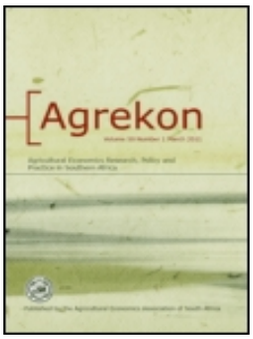

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A MICROECONOMIC ANALYSIS OF THE SOCIO-ECONOMIC SITUATION ALONG THE KAT RIVER WATER BASIN: COMMENT

Wittmann, Nadine*

ABSTRACT

According to Mbatha and Antrobus (2008), basic economic models are inadequate for explaining the socio-economic situation of farmers along the Kat River water basin (KRV) as their results do not reflect their empirical findings. However, this is due to the fact that the economic model implemented is not tailored according to the specific characteristics of the region. Therefore, this paper incorporates the latter in a microeconomic model. Once all the relevant factors are accounted for, an economic model may very well suffice to depict the socio-economic situation present in the KRV, which is in contrast to previous findings.

Keywords: institutions, river sharing, location-specific externalities, farming, Kat River Valley

JEL Codes: D24, Q12, Q24, Q25

1. INTRODUCTION

In many regions of the world, the availability of clean water has become not just a question of increased environmental awareness but of economic subsistence, and in some cases even survival itself. Although the situation might have improved in some regions, many countries face a severe threat of water scarcity (Grafton *et al.*, 2009). In the case of river basins, economic and environmental issues prove to be especially location dependent, as the unidirectional flow of the water determines that water-related activities of upstream locations are to affect downstream users but not vice versa. Hence, in many regions this causes downstream locations to be worse off if the market for water consumption or pollution remains unregulated, given that no other region-specific aspects come into play. A detailed literature overview regarding these kinds of problems focusing on river sharing can be found in Beard (2011).

The situation along the Kat River basin, however, is slightly different. Hence, Mbatha and Antrobus (2008) point out correctly that, in this specific case, the

* TU Berlin, Str. d. 17. Juni 135, Sekr. H 50, 10623 Berlin, Germany.
Email: nadine.wittmann@tu-berlin.de

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general prediction that downstream locations are worse off[1] compared with upstream locations does not hold true – assuming that water is both scarce and a crucial input in economic activities. Hence, they argue that Bromley's Physical Externality Model (PEM) is neither useful nor accurate (Mbatha and Antrobus 2008:475). As will be shown below, however, these results are caused by, metaphorically speaking, comparing apples and oranges. If, however, all of the relevant information is taken into account, a simple economic model may suffice to depict the situation within the KRV.

The paper is structured as follows: Section two gathers the information relevant for the model set-up. A basic economic model is set up in section three. Section four presents a graphical analysis. Section five comprises some concluding remarks.

2. ECONOMIC ANALYSIS OF KRV STATUS QUO

> A word of caution for economic research undertakings from this discussion would be, firstly, to discard any belief that economic models can provide enough or even suitable tools for explaining socioeconomic systems, secondly, to always factor and investigate the effects, at least, of the most dominant institutions in their practice on the ground (Mbatha and Antrobus 2008:486).

Naturally, just as you might find it difficult to cook a tomato soup without adding any tomatoes, it will prove quite hard to set up an economic model without taking into account established laws or practice[2] that affect the economic activity in question. Hence, the second part of the latter quotation is certainly absolutely essential to economic modelling. The first part, however, is to be refuted in the following sections.

In general, the KRV can be divided into three sections, namely the Upper, Middle, and Lower Kat River. In each section, many farmers are engaged in citrus fruit production. According to the empirical data and its analysis presented by Mbatha and Antrobus (2008), some of the most important aspects regarding the situation in the KRV are:

- First of all, there is not just one but two externalities, one in water usage and one in land availability (Mbatha and Antrobus, 2008:478).
- There is also a regulatory scheme imposed regarding water usage, which, in part, also implicitly depends on the amount of land developed for farming (Mbatha and Antrobus, 2008:480).
- In addition, to some extent, land development is a substitute for Kat River Water (Mbatha and Antrobus, 2008:480; 483–484).
- Land availability differs across river sections, being highest in the Lower Kat River region and extremely limited in the Upper Kat River region (Mbatha and

Antrobus, 2008:481).

There are several more peculiarities, such as the fact that Middle Kat Farmers have control over a river dam and thus are able to control water flows to the Lower KRV, to a significant extent (Mbatha and Antrobus, 2008:484). Overall, however, both Middle and Lower Kat Farmers are closely linked to water scheduling authorities (Mbatha and Antrobus, 2008:480) and therefore hold an advantage with respect to water scheduling compared with Upper Kat Farmers. These are roughly the most prominent and important characteristics of the situation prevalent in the KRV.

From these findings, it becomes clear that the situation in the KRV differs greatly from that of a single externality prevalent among otherwise homogeneous agents located alongside a river basin who use its water flows as a scarce input of an identical economic activity. Therefore, it is absolutely non-surprising and undoubted that a basic unadapted version of Bromley's PEM can never portray the situation correctly. Basically, Bromley's PEM is meant to apply Hardin's well-known Theory of the Tragedy of the Commons (Hardin 1994) to a river basin given the latter assumptions on the agents and externality involved. Under any other circumstances, such as those in the KRV, the situation has to be modelled using a different or, at least, appropriately adapted economic model.

3. THE MODEL

In the following model, it is assumed that the farmers located along the Kat River Basin are mostly occupied with citrus production. The River Basin is geographically divided into three sections, namely Upper (i=1), Middle (i=2) and Lower (i=3) Kat. The most important input factors to producing citrus (z_i) are Kat River water (w_i), which is diverted individually, and land (l_i). All agents are supposed to be risk averse. In the Middle Kat section there is a water dam, which is operated and controlled by Middle Kat farmers. Kat River water and land are substitutes, to a certain extent[3]. However, as they are not perfect substitutes, there is a certain minimum amount of both land and water required to engage in citrus production, $w_i \geq \underline{w}_i$ and $l_i \geq \underline{l}_i$. Moreover, there is also an upper bound to both input factors, i.e. $\overline{w}_i$ and $\overline{l}_i$, which also varies from section to section. These bounds result from historical, institutional, and political factors and are given exogenously. With respect to land, settlement patterns result in high land development restrictions for Upper Kat farmers, less severe but still restrictive development opportunities in the Middle Kat, and large land development opportunities for Lower Kat farmers, $\underline{l}_3 > \underline{l}_2 > \underline{l}_1$. In the case of Kat River water, the restriction pattern depends on whether there is a regulatory framework in place or not:

(a) If there are no restrictions on water usage, the externality in water consumption

works exactly the other way around. In this case, Kat River water usage is most restricted in the Lower Kat section, while it is less scarce in the Middle Kat section due to farmers' control over the Kat Dam, and relatively unrestricted in the Upper Kat section, due to farmers' location advantage of being closest to the Kat River's source. In this case, the two externalities with respect to land and water usage move in opposite directions, and, hence, $\underline{w}_3 < \underline{w}_2 < \underline{w}_1$.

(b) If this is a regulatory scheme in place, as is the case in the KRV, its effect depends on the way aggregate water supply is divided among regions and how well sanctions for non-compliance can be imposed. As we know from Antrobus and Mbatha (2008), it appears as though Middle Kat farmers hold the most influential position with respect to water allocation decisions, followed by Lower Kat Farmers. Upper Kat Farmers are small in relative company size and come in last. As water rights are allocated according to the amount of land developed, they are thereby endowed with a relatively small amount of water rights. In this case, we have $\underline{w}_1 < \underline{w}_3 < \underline{w}_2$. As has been hinted at before, is the relevant setting in the case of the KRV. Hence, closer analysis shows clearly that there is actually not just one externality but two externalities prevalent. Each of them affects one of the two input factors.[4] Overall, it appears obvious, that, in order to analyze the situation described above, some microeconomic theory other than an Edgeworth box must be applied.[5]

4. ANALYTICAL AND GRAPHICAL ANALYSIS

All farmers, Upper, Middle and Lower Kat farmers, produce citrus fruits using the two input factors, land and water. In order to simplify the analysis, let's assume that there is one representative farmer located in each of the three regions. Moreover, in order to confine the analysis to the supply side, it is assumed that all farmers produce citrus, $z_i = (w_i, l_i)$, which is sold at an exogenously given market price $\overline{p}$, using location specific amounts of the two input factors, w_i and l_i. The prices of the input factors, p_w and p_l, are assumed to be constant and known and exogenously given as well. As a maximization problem this setting appears as follows:

$$\max_{w_i, l_i} \quad \overline{p}\, z(w_i, l_i) - p_w w_i - p_l l_i \tag{1}$$

s.t.

$$\underline{w}_i \le w_i \le \overline{w}_i \text{ and } \underline{l}_i \le l_i \le \overline{l}_i \quad \forall i, i = 1,2,3 \tag{2}$$

Given the fact that the two input factors are assumed to be substitutes[6] and that output prices are given, input demand will depend on the input's prices and the restrictions on availability as well as the fact that the farmers are assumed to be risk averse. On the one hand, the price of Kat River water is expected to be very low –close to zero – as water can be diverted individually and there are no further costs associated with water diversion, $p_w \rightarrow 0$.[7] On the other hand, the developing of land for citrus production requires a more costly, long-term investment, $p_l > p_w$. Therefore, equation can be changed to a cost (Ci) minimization problem including the restrictions specified in equation :

$$\min_{w_i, l_i} \quad C_i(w_i, l_i, p_w, p_l) \tag{3}$$

s.t. equation. (3)

Thereby, the following graph emerges, given demand of and restrictions on the input factors and all of the other assumptions made in advance:

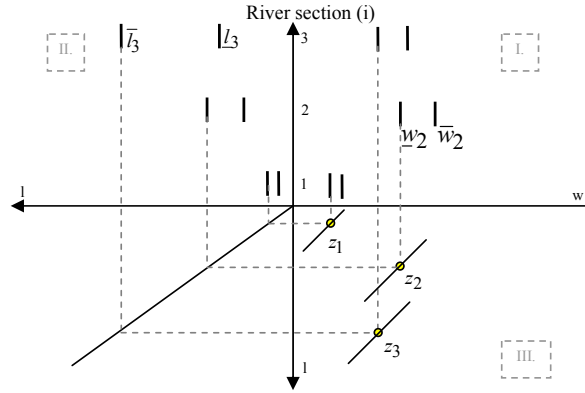

Figure 2: Input factor combination

Source: Author's design

In the cost minimizing equilibrium, risk aversion with respect to expected water flows causes farmers to demand the minimum water flow to reach their region,

which is equal to the maximum amount they perceive available for production in this set-up. Assuming that $l_i = \underline{l}_i$ [8] is the binding cost minimizing condition of our optimization problem with respect to the input factor land, all farmers use the maximum amount of land available. Due to the conditions prevailing in KRV, this leads to Lower Kat farmers being on the highest production possibility frontier, followed by Middle Kat Farmers. Upper Kat subsistence farmers come in last:

$$z_1^*(\underline{w}_1, \overline{l}_1) < z_2^*(\underline{w}_2, \overline{l}_2) < z_3^*(\underline{w}_3, \overline{l}_3) \tag{4}$$

This also implies that, given a fixed market price $\overline{p}$ for citrus output, Upper, Middle, and Lower Kat farmers achieve different revenue levels. The resulting distributional effects that are caused by higher profits of downstream farmers are likely to result in both higher economic and social influence of Middle and especially Lower Kat Farmers, which was mentioned by Mbatha and Antrobus (2008) in their analysis.

Of course, this is a very confined model of the citrus market. It employs, among others, a simplifying assumption that there is a given equal amount of citrus produced in each section. However, the article by Mbatha and Antrobus (2008) also focuses on the supply, that is the farmers' side of the market and does not provide the reader with any information on citrus market prices or demand. Thereby, given the information about the region and agents involved, this economic model manages to explain the status quo in the KRV, although some additional simplifying assumptions with respect to production costs and citrus demand have been made.

5. CONCLUSION

The analysis in this set-up – just as in that of Mbatha and Antrobus (2008) – is not concerned with ecological effects of water flow levels but simply with analysing the socio-economic situation in the KRV. As has been shown in the previous section, it is correct that location specific input availability may lead to distributional effects. The previous analysis shows, that in contrast to the statements of Mbatha and Antrobus (2008), these socio-economic effects can, indeed, be depicted and analysed by using an economic model implementing an economic toolbox. Thereby, this paper has presented a valuable scientific contribution by constructing an economic model, which is able to explain the status quo prevalent in the KRV. Mbatha and Antrobus (2008) are certainly right in postulating that it is of high importance that economic or regulatory models not be implemented without a careful analysis of the setting in question. But then, this situation is quite similar to that of constructing a proper questionnaire and selecting a proper panel for a socio-economic empirical study. If the questions are not posed correctly and the wrong

people are asked, chances are that the results will not reflect reality correctly. If both theoretical and empirical model set-ups are conducted appropriately, viable results can be achieved either way. Therefore, in economic terms, this paper takes the analysis of Mbatha and Antrobus (2008) one step further by incorporating their findings into an economic model that actually manages to depict and explain the socio-economic status quo prevailing in the KRV correctly.

NOTES

1 It is assumed that water is both scarce and a crucial input to economic activity.

2 Definition of "institution" as in http://oxforddictionaries.com/definition/institution?q=institution (accessed 20 June 2012).

3 If additional land is developed for farming, new wells and other rivers running through these lands can be used by the farmers to water their plants. Hence, the more land, the more non-Kat River water is available to farmers. Therefore, land can be perceived as a substitute for Kat River water, to a certain extent.

4 Of course, these circumstances are not caused by the agents involved in citrus production. Therefore, the term "externality" might appear a little awkward or even false. However, the author intends to convey the fact that the availability of both input factors is affected by location-specific aspects.

5 Surely, an Edgeworth box can be used to describe the allocation of two input factors among two producers. However, first of all, Mbatha and Antrobus differentiate between *three* different River sections and not just two. Moreover, Edgeworth's box is all about showing the possible potential of gains from trade, resulting from inefficient initial allocation of resources. However, although Kat River water might be tradable, downstream farmers cannot trade land to upstream farmers given the assumption that those do not want to move or at least diversify their location pattern

6 Within the boundaries of minimum/maximum input requirements/availability.

7 The costs of building the Kat River Dam are not included for consideration in the analysis, for reasons of simplicity and clarity. Mbatha and Antrobus did not go into further details about these costs either.

8 Assuming that $p_w < \overline{p}$, land will be developed as an input for citrus production until one of the two conditions $p_l = \overline{p}$ or $l_i = \underline{l}_i$ holds.

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