Macroeconomic and institutional sources of environmental changes— the case of Israel’s water sector

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Abstract

The paper examines the macroeconomic and institutional sources of environmental development in Israel’s water sector, for example changes in drinking-water quality, sewage treatment and aquifer depletion trends. It is shown that Israel’s economic growth process was, by and large, accompanied by environmental improvements in the water sector; but it is the institutional approach which provides a cohesive explanation of how environmental changes took place. Implementing reforms in Israel’s water sector without adequately addressing the institutional aspect might thus undermine the success of such plans.

Keywords: Environmental change; Environmental Kuznets Curve; Institutional; Israel’s water sector; Macroeconomic

1. Introduction

Water is one of the primary environmental concerns, its importance being highlighted in recent years, particularly since the 2002 Johannesburg summit. Israel is considered to be a leader in water-resources management (Feitelson, 2005), applying various policies for coping with extreme water scarcity (Shelef, 2001; Tal, 2002, chapter 7). These two observations provide the starting point for examining the economic and institutional dimensions of environmental changes as manifested in Israel’s water sector.

The link between environmental changes and economic growth has been much investigated within the framework of the Environmental Kuznets Curve (EKC) hypothesis\(^1\) which suggests that while harming the environment, economic growth also increases the demand for an improved environment (being a luxury good) and generates the resources needed to address environmental concerns. The EKC model (also referred to as the inverted-U model) attracted much analytical and empirical attention, but Stern’s (2004) critical review of this literature showed it to “have a very flimsy statistical foundation”

\(^1\) Following the connection, analyzed by Kuznets (1955), between income-distribution equality and per capita gross domestic product (GDP).


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Moreover, testing the validity of the EKC hypothesis for a single country and/or a single sector poses further statistical problems. This paper examines the question of a lower order of complexity than that posed by the EKC: Did environmental changes in Israel’s water sector follow macroeconomic developments in a recognizable manner, or were the changes independent of the economic growth process?  

Israel’s uncommon combination of being economically developed and suffering from water scarcity (Allan, 2001) is reflected in the institutional setup of its water institutions, as analyzed in Galnoor (1978). But while the economic, political and environmental aspects of Israel’s water sector have been the subject of ongoing academic scrutiny (see Dery & Salomon, 1997; Kislev & Yavas, 1997; Sherman, 1999; Kartin, 2000; Menachem, 2001; Feitelson, 2002; Kislev, 2002; Mizrachi, 2004; Fischhendler, 2006 and many more), the evolution of the sector’s institutional setup did not attract similar interest, in spite of the changes that took place in it. This paper aims to fill this gap and examine how the institutional setup of Israel’s water sector adapted and the reasons behind the changes. This analysis is performed via a historical account of the institutional changes. A third goal of the paper is to provide the background for analyzing the strengthening of one of the water sector’s main institutions, the Water Commission. While such a reform has been discussed for a very long time in professional circles (see Galnoor, 1978 and numerous reports afterwards), in 2006 Israel’s parliament approved a specific reform plan, submitted by the Ministry of Finance, and accordingly in 2007 Israel’s Water Authority started operating.

The next section introduces Israel’s water sector and Section 3 presents the institutional developments which were applied to the sector. Sections 4 and 5 analyze the macroeconomic and institutional dimensions of environmental developments in Israel’s water sector, respectively. Section 6 discusses the paper’s main findings and Section 7 concludes.

2. An environmental perspective of the Israeli water sector—background and characteristics

Israel is one of the few countries which while being highly developed is in short supply of freshwater resources (Allan, 2001). Thus, since its establishment in 1948, Israel’s economic development has been accompanied by an ambitious drive to capture and utilize its limited water resources. This drive consisted of two major steps: first, tapping all major freshwater resources, connecting them to one state-wide system and building the national water carrier (completed in 1964), which conveys water from Lake Kinneret (the Sea of Galilee) in Israel’s north to the arid south. In the second stage, started in the 1970s, wastewater treatment facilities and a transfer system were built, which enable the reutilization of 85% of its sewage water (The Hydrological Service, 2005). Israel’s hydraulic drive was accompanied by a continuous—state-sponsored—effort to make agriculture, water’s main user, highly water efficient (Arlosoroff, 1995). Another major feature of this drive was the supply of unrestricted quantities of water (of continuously improving quality) for domestic uses, to a fast growing population.

Israel’s water system is to a very high degree state-managed. The 1959 Water Law de facto nationalized all of Israel’s water resources (including wastewater) and decreed water distribution according to administrative and political decisions. The Water Law created the institutional framework for administering and monitoring all extractions and uses of Israel’s waters (Arlosoroff, 2001).

2 An ad hoc EKC interpretation of developments in Israel’s water sector is presented in the Appendix.
Tapping all major freshwater resources had a detrimental effect on Israel’s streams and rivers. Moreover, with growing domestic use, wastewater flows increased and most of these flows were disposed of into riverbeds and the Mediterranean. While directing wastewater into natural habitats stopped gradually with the building of treatment facilities (currently most of the wastewater in Israel is treated to a secondary level), Israel’s freshwater resources kept being overutilized. Increasing freshwater use led to a drop in water levels in the aquifers in the 1980s and again in the late 1990s, around the drought of 1999–2000. Consequently, Israel’s aquifers were exploited in an unsustainable manner (Gvirzman, 2002). Interestingly, unlike in the case of its aquifers, the waters of Lake Kinneret, Israel’s major surface freshwater source, were intensively used but not necessarily overutilized (The Hydrological Service, 2005).

Applying a state-response framework, Margoninsky (2004) advanced a set of eight indicators, which provide an overview of the development of Israel’s water-sector—the first four indicators are quantitative and the other four are qualitative: (1) the state of the water resources (the aquifers and Lake Kinneret); (2) water usage patterns in agriculture—intensification and conversion to treated sewage; (3) water quality at the tap; (4) wastewater recycling; (5) resource-management infrastructure—building water projects and concentrating legal and administrative powers; (6) regulating Mediterranean coastal waters—‘cleansing’ the open sea and enforcing standards; (7) rivers—administration and rehabilitation efforts; (8) Lake Kinneret—administration and management. These indicators are utilized in the analysis presented in Section 4, while the next section describes the institutional facet of Israel’s water sector and the way it developed over time.

3. The institutional setting of Israel’s water sector

The institutional structure of Israel’s water sector divides schematically into two systems, the first dealing with water supply and the second with water quality. The development of these systems is presented in subsections 3.1 and 3.2, respectively. Subsection 3.3 addresses the recent reform of the Water Commission, which deserves separate attention as it is still in the making.

3.1. Water supply—institutional structure and institutional change

Following its establishment in 1948, Israel faced a major challenge regarding its water resources. It needed to extend the water supply to its burgeoning population, as well as for the settlement of peripheral areas. Such settlement was perceived as essential in the nation building process, for the absorption of new immigrants and to secure food supplies, as well as for securing the new borders. To this end the Mekorot water company (which had been the water supplying organ of the Jewish labor movement since 1937) became a national water company and TAHAL was formed as the state’s water-planning agency. In the early state years TAHAL was responsible for planning the main water works, while Mekorot carried out the plans and operated the water system.

3 See Feitelson & Chenoweth, 2002, on using a set of indicators to analyze the water sector, versus using one aggregate indicator.
A third body—the Water Commission—was formed under the 1959 Water Law. While legally it was responsible for the operation and regulation of the water sector, in practice it was heavily dependent on TAHAL and to a lesser extent on Mekorot for professional expertise (Kahane, 2002). Thus, by the 1960s a de facto trilateral institutional structure was formed: the Water Commissioner allocated water quotas to farmers, TAHAL planned the water system and Mekorot operated it.

After Israel’s national water system had been planned and its execution had been completed in the 1960s, TAHAL shifted the focus of its business away from the sector to other planning activities and to consulting in other countries. This process was completed in 1996, when TAHAL was privatized (Afron, 2003) and the Water Commission fully assumed the responsibility for planning the water system.

The Ministry of Finance assumed an increasingly important role in the water sector in the 1990s, as TAHAL in its old capacity atrophied and after the ministry managed to curb Mekorot’s clout (Kislev, 2002). In fact, the ministry became the ultimate arbiter regarding new water projects (Nisan, 2003). By and large it blocked the building of water projects, for example a major new sewage conduit and water desalination plants, since such projects were unprofitable at the price paid by farmers for water (Shochat, 2003).

The growing influence of the Ministry of Finance and the curtailment of new water projects were a manifestation of a shift within the professional water community. Until the 1990s Israel’s water establishment was a cohesive, engineering-dominated community. By the early 1990s economists became increasingly vocal, mainly arguing for “economic” water pricing. The result was an increasingly fragmented water community. This may be seen as a reduction in the social capital within the water sector. The reduction took place as an informal and tightly knit network of water practitioners, all (regardless of institutional affiliation) addressing the water sector as part of a nation-building effort, became a system of various and at times conflicting institutional agendas (Feitelson, 2002).

### 3.2. The institutionalization of water quality concerns

According to the Water Law all water-related issues, including quality concerns, are the responsibility of the Water Commissioner. However, in practice, the Water Commissioners neither dealt with water-quality issues, nor encouraged other institutions to assume this role. Thus, until the 1970s, no attention was given to wastewater treatment and recycling (beyond very rudimentary and extensive treatment in oxidation ponds and local recycling). This started to change in 1970, following an outbreak of cholera in Jerusalem, which was caused by raw-sewage irrigation and which—if repeated—would have had dire consequences for Israel’s image abroad and its tourist industry. At the same time, all options regarding tap-water resources were exhausted and turning treated sewage into a new source of water became appealing (Tal, 2002).

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4 For a description of the personal power struggles which influenced the formation of the trilateral institutional structure, see the memoirs of Tahal’s first supremo in Blass (1973).
5 The question of whether this is only one manifestation of general strengthening of the Ministry of Finance is beyond the scope of this paper.
6 In 2006 the Water Commissioner was replaced by the head of the Water Authority. See subsection 3.3.
In 1970 the government initiated the national sewage project, which consisted of building about 50 treatment plants across Israel. The major plant, the Shafdan, treats about one-quarter of Israel’s sewage, which is then transferred to the south of the country and used in irrigation. In 1993 the Ministry of the Interior established the Sewage Infrastructure Administration, which built about 20 more sewage treatment plants, all using advanced treatment processes (State Comptroller, 1971; Ramati, 2002).

Three additional institutions influenced water quality issues: the Ministries of Health and of the Environment (and its predecessor agency) and the Kinneret Administration.

The Ministry of Health (1979–2000) dealt with drinking and coastal water quality. Between 1963 and the early 1970s it monitored drinking water quality according to non-legally binding standards (Burla, 2001; Zohar, 2001). This reflected the Water Commissioner’s (and the Ministry of Agriculture’s) unwillingness to relinquish legal powers concerning water (Laster, 1980: p. 272). In 1970 the Public Health Act was amended to give the Minister of Health a legal mandate over the sanitary quality of drinking water. Since 1974 the Minister of Health has issued orders regarding drinking water quality and monitors compliance with them (Burla, 2001). Since 1992 the Health Ministry has also monitored coastal water contamination. Once contamination climbs above levels allowed by the ministry, beaches are closed for bathing (Fish, 2001).

Establishing an agency with responsibility for Lake Kinneret’s water quality was suggested in the 1960s, but the Water Commissioner blocked it, as it would have limited its own influence (Tal, 2002: p. 48). The Kinneret Administration was founded in 1971, following a public outcry aroused by a critical limanological report (Tal, 2002, p. 235). Since its establishment the Kinneret Administration has successfully protected the quality of Lake Kinneret’s waters.

In 1973, the Environmental Service was created, partly as a result of technocratic entrepreneurship by professionals, influenced by the rising environmental awareness at the time (Marinov, 2002). In 1988 the Ministry of the Environment was formed and replaced the Environmental Service. Owing to the institutional crowding in the water sector, the service and later the ministry chose to focus on issues that were not in the remit of other institutions—mainly coastal waters. The latter was made possible by the Ministry of Transportation’s relinquishment of its authority regarding the Mediterranean (Marinov, 2002). Following the ratification of the Barcelona Convention for the protection of the Mediterranean, specific laws for the protection of the sea from pollution were enacted and appropriate monitoring and enforcement mechanisms were put in place (Golick, 1989; Brachya, 2001). At the beginning of the 1990s the Ministry of the Environment initiated rehabilitation efforts for 13 rivers. This effort still has to bear fruit (Ministry of the Environment, 2000; Shapira & Mazor, 2001).

3.3. Reforming the water commission

As noted above, in 1959 the Water Commission was established. It was headed by a Commissioner, who reported to the Minister of Agriculture (later the Minister of Infrastructure) and had to consult an advisory Water Board—comprising water users, first and foremost among them the farmers. While the need for reform of the Water Commission has been discussed for decades (see for instance Galnoor, 1978; Shamir et al., 1985; Arlosoroff Report, 1997), it is only recently that such a plan was put

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7 The Kinneret Administration has never been endowed with a specific legal mandate. Its legal powers are derived from an ad hoc interpretation of the existing legal framework regarding water resources.
forward by the government. The proposal had been included in the Economic Arrangements Law (Supplementary to the Budget), proposed by the Ministry of Finance (http://www.mof.gov.il/budget2006/ and http://www.mof.gov.il/bud_frame_e.htm) and was approved by Israel’s parliament (the Knesset) as part of the (belated) 2006 budget debate.

The proposal’s main feature is the establishment of a new government agency, the Water Authority, which will replace the Water Commission. The new agency will retain all the legal powers of the Commission and will also be given powers over urban water corporations and agricultural drainage. More importantly, legal authority concerning water resources, currently held by the Minister of National Infrastructure (and previously held by the Minister of Agriculture) will be transferred to the head of the new authority and a newly established council. The council will comprise the head of the authority and the general managers of the Ministries of Agriculture, Environment, Interior, National Infrastructure and the Budget Office (in the Ministry of Finance). According to the proposal, the wings of the Commission’s advisory board will be clipped.

The dispersion of water sector responsibilities between various governmental departments was much criticized over the years as being detrimental to the rational management of the sector (see, for instance Parliamentary Investigation Committee into the Water Sector, 2002). The manifest objective of the proposal, announced by the government in August 2005, was thus to put such legal authorities under one roof (http://www.mof.gov.il/budget2006/ and http://www.mof.gov.il/bud_frame_e.htm). But it seems that an equally important raison d’être of the proposal is strengthening the role of the “professional” level in managing the sector and weakening the influence of the “political” level and specifically reducing farmers’ clout on the prices they pay for irrigation water.

Kislev (2005) finds many faults in the Ministry’s proposal: on the good-governance front, the proposal was concealed within an omnibus law, sidestepping a necessary public debate on the proposal’s merits and demerits; on the public-resource-management level, it creates an unholy union between resource management and economic regulation of water and sewage utilities; and on the practical level it endows the new agency with authority (concerning drainage and urban water corporations) which would be better placed with other agencies. Another critique (Fischhendler, 2006) is that rather than removing the debate about a public resource like water further from the public and political arena to a “professional” one, it should be transferred to a body comprising all interested sectors, including farmers, urban-dwellers and environmental groups.

One of the major failures of the water commission was its acquiescence in the face of excessive usage of Israel’s limited water resources, in spite of the fact that it had been endowed with the legal mandate and powers to prevent it (Parliamentary Investigation Committee into the Water Sector, 2002; Zaslawsky, 2002; Feitelson et al., 2005; Kislev, 2005). Thus a major criterion in assessing the proposed reform is whether the new agency is better placed to manage Israel’s water resources in a non-excessive way than the current Water Commission. The main reason behind the excessive usage of water resources was Israel’s farmers’ political clout (Feitelson, 2005; Feitelson et al., 2005). But the alleged independence of the new agency, namely the fact that it is no longer subordinate to a minister, will not necessarily curb farmers’ clout. Farmers, who in the past managed to block water price hikes in the Knesset committees, will still be able to do so. More so, the government could, for instance, choose a pro-farmer head of the Water Authority, or overrule the head of authority’s decisions concerning the price of water for irrigation.

The proposed agency, thus, is hardly a substitute for a reform according to which water prices would be equal for all users, with farmers compensated for the abolished water-price subsidies through direct
assistance (in proportion to the land they work). Such a reform had been worked out in the past by the Ministries of Finance and Agriculture, but was turned down by the government in April 2003\(^8\).

4. The macroeconomic dimension: environmental changes \textit{vis-à-vis} economic growth

Israel’s economic growth path from the mid-1950s to 2000 can be divided into three distinct stages (Bruno, 1986; Rivlin, 1992; Ben Basat, 2002):

1. Mid 1950s–1972, often referred to as the “golden age”, owing to rapid GDP growth rate (9.2% annually between 1960 and 1972).
2. 1973–1984, frequently called the “lost decade”, as growth rates were low (3.4% annually, on average), in comparison to past performance and growth potential.
3. From 1985 to 2000 Israel has been edging towards a more market-oriented economy. The growth rate (4.6% annually on average, 1985–2000) is fast in comparison to the previous period and to other developed economies.

Applying the state-response framework presented in Section two, the trends of the eight indicators during the three stages of Israel’s growth period are summarized in Table 1 in the following manner: “1” indicates environmental improvement; “−1” indicates environmental degradation; otherwise they receive the value “0”. For instance: tap-water quality did not receive much attention during the first stage, but was dealt with intensively during the other two periods; it therefore receives the value “0” for the first period and “1” in the other two. On the other hand, water usage patterns in agriculture improved throughout all three periods, so that the second indicator was given the value “1” in all three. The resource-management infrastructure was laid down during the first period, in a way that facilitated the intensive usage—and exploitation—of water resources. Flaws were identified by many analysts in the subsequent decades, but were not addressed. This indicator thus attains the value “−1” for the first period and “0” in the other two.

The indicators’ longitudinal development, as portrayed in the table, suggests that one parameter—the state of water resources—unequivocally deteriorated over time. All other indicators improved or did not change, namely they kept pace with Israel’s long-term economic growth process. This raises the question, why did these contrasting trends take place? This is addressed in the next section, applying an institutional perspective\(^9\).

5. The institutional dimension: externalities, transaction costs and inertia

Feitelson & Fischhendler (2006) present an analytical framework of institutional groundwater management which is based on two conflicting elements: externalities and transaction costs. While

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\(^8\) The abortive reform was based on pricing water according to marginal production costs. Lately the Ministries of Agriculture and Finance discussed raising water prices paid by farmers to the level of (obviously lower) average production costs.

\(^9\) See footnote\(^2\).
externalities, for example rising extraction costs caused by intensive pumping (by other users), do motivate the creation and development of such institutions, the transaction costs of setting up new institutions impede such development.

An additional impediment to the development of water institutions (and to the creation of new ones alongside older institutions) is caused by institutional inertia, that is the resistance of institutions to change (Challen, 2000; OECD, 2001). Overcoming such inertia might necessitate the exploitation of “policy windows” by government agencies or other institutions (Kingdon, 1984).

Extending Feitelson & Fischhendler’s (2006) framework and applying it to the water sector of a fast-developing water-scarce country would thus provide us with the following scheme: population growth and/or economic growth increase the demand for water, until the consequences of externalities are felt. Responding to such consequences, water institutions are created initially in order to manage scarce water resources. Such institutions focus on resource development. As demand keeps increasing, resource depletion—caused by the existence of externalities—takes place, often accompanied by additional trends such as quality deterioration and desiccation of aquatic ecosystems. At the same time local environmental awareness might rise, mainly owing to the increasing prominence of environmental issues in the international arena (thus exogenous to the model).

The combination of exploited water resources and growing environmental awareness might generate pressures for institutional change, while inertia, on the other hand, might stem such changes. Institutional changes will take place in spite of powers of inertia only under certain circumstances, for instance if an imminent crisis is perceived, thus opening a “policy window” or if water-policy entrepreneurs manage to align sufficient institutional backing to support their policy proposal.

The water sector was given its institutional structure in the 1950s and 1960s, at a time when a small cohesive professional group dominated the water sector. The group dealt with the externalities embedded in the water sector in two ways: legally, internalizing externalities via the 1959 Water Law, and institutionally, through creating the trilateral institutional structure. In the following decades, as new concerns—mainly environmental—emerged, the institutional structure evolved slowly, facing significant opposition from the existing institutions. Thus, institutional changes (e.g. the creation of the national sewage project and the establishment of the Kinneret Administration) tended to occur at times of crises and related mainly to water quality. Inertia did, by and large, prevail, with regard to the water supply system, which was regarded by the Water Commissioner as the core of its jurisdiction.

Following the supply crises of the late 1980s and the 1990s, increasing calls for a change in the institutional structure of the water supply system were presented in reports by various committees

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Table 1. Longitudinal changes in Israel’s water sector.
investigating the sector. For a long while these had no bearing on the institutional make-up of the water sector and while the recent proposed reform of the Water Commission seems to indicate the end of this inaction, only its implementation will prove this to be true.

Thus, the pattern of institutional change where institutional inertia is overcome mainly in crisis situations, when policy windows are created, is generally in line with the changes that occurred (and did not occur) in the institutional structure of Israel’s water sector. Yet for a long time this pattern seemed hard to reconcile with the deterioration in the state of the water aquifers, which took place despite the fact that the water-sector institutions had all the technical know-how, legal authority and administrative capacity to prevent it and despite the fact that the droughts of 1985–6, 1989–91 and 1999–2001 provided adequate opportunities for overhauling the institutional setting.

6. Discussion

Two alternative approaches to the origins of environmental changes have been applied in this paper, in the context of Israel’s water sector. The first, a macroeconomic approach, indicated that in the long run, environmental improvement went hand in hand with economic growth. This conclusion sits well with economic intuition that environmental benefits are “normal goods” and demand for them rises with income.

Nevertheless, the application of the macroeconomic approach has a general drawback, which is clearly demonstrated in the test case analyzed in this paper: Most, but not all environmental parameters examined in this paper improved over time, thus the approach did not provide a clear-cut outcome. This seems to indicate that environmental changes are not solely determined by the pressures of higher demand for environmental benefits, a point which is elucidated once the nature of environmental improvement is exposed.

Unlike tangible “normal goods”, environmental benefits often are public goods. They are introduced in a highly complex way, which cannot be solely attributed to growing demand and market forces. But then, the macroeconomic approach (as well as its more sophisticated kin, the EKC)—by virtue of being a black box—does not reveal specific reasons for environmental changes, limiting itself to pointing out the correlation with economic growth. The economic approach thus provides a very partial explanation for the forces and reasons lying behind environmental changes.

Applying the institutional approach in this paper, on the other hand:

1. provided a cohesive explanation of the way environmental changes took place in Israel’s water sector;
2. highlighted the institutional facet of a major characteristic of Israel’s water sector development, that of the sophisticated utilization of water resources, versus weakness in the management of aquifers in a sustainable manner.

7. Conclusions

Using water resources involves externalities. Such externalities are the raison d’être for applying public policy in the water sector and public policy is usually executed through institutions. Following
this line of reasoning, the paper showed that developments in Israel’s water sector can indeed be explained through applying an institutional perspective.

An obvious conclusion thus to be drawn is that plans to reform the sector which overlook the institutional facet might fail. The current reform in the management of Israel’s water sector is a case in point: its emphasis is on distancing decision-making from politics, not on properly restructuring the institutional make-up of the sector, following an open public and professional debate on the nature of such a reform. This is especially regrettable since pushing such reforms through often necessitates the existence of a “policy window” (Kingdon, 1984), which does not open too frequently.

The major shortcoming of the institutional approach is that by itself it is of little help in predicting future changes, as it does not predict when inertia is expected to prevail and when it will not. Such developments can be explained using a political–economic approach (Feitelson, 2005; Margoninsky, 2006). Developing a combined—institutional cum political–economic—model of the water sector thus ought to be a next step in the investigation.

Acknowledgements

The paper benefited greatly from Raul Drachman’s suggestions regarding the analysis in the Appendix and from comments from Yoav Kislev, David Stern and an anonymous referee on the Israeli water sector, the Environmental Kuznets Curve and various other points, respectively. All errors and omissions should be attributed to the author.

References


Appendix

An ad hoc EKC perspective of Israel’s water sector development

Israel’s economic growth, while insufficient to portray a genuine EKC, facilitates the portrayal of a hypothetical one. Assuming the EKC indeed exists, Israel’s economic development trajectory would lead us to expect environmental degradation during the first period, when per capita GDP grew from US$6,000 (in constant US$2,000) to US$12,000; and environmental improvement during the third period, as per capita GDP grew from US$13,000 to US$18,000. In the interim “lost decade”, both environmental decline (owing to the sharp slowdown in growth) and the opposite (owing to the relatively high per capita GDP growth rate) are possible.

As can be verified in Table 1, most of the eight indicators behave in accordance with such a hypothetical EKC. But because not all of the indicators behave in this way, the examination of the hypothesis calls for the establishment of an aggregate criterion. An ad hoc criterion is attained through averaging the eight values for each of the three eras, thus permitting us to assess the (average) direction of environmental change during that period. The closer the calculated value is to “−1” in the first era and to “1” in the third, the more consistent it is with the EKC hypothesis. As for the second period, which is a transition period between the two stages, the values attained should lie in between those calculated for the other two eras.

The average values attained from Table 1 (−0.25, 0.38, 0.63 for the first, second and third eras, correspondingly) are consistent with an inverted-U trajectory.

The ad hoc criterion suffers from one major drawback: the weights of its components cannot be derived endogenously and have to be chosen arbitrarily. The equal weights applied above seem to be a natural choice, but are assumed, rather than derived analytically. This drawback cannot be fully remedied. But the conditions, namely the weights, under which the EKC hypothesis will be disproved, can be determined in the following way, first defining the “composite value” as a weighted average of all individual values (−1, 0, 1) in each category, for each period.

Define:

\[
y_t = b_1 x_{1t} + b_2 x_{2t} + \ldots + b_8 x_{8t}
\]

\[
j = 1, \ldots, 8
\]

\[
t = 1, 2, 3
\]
Thus we define, for each period, a composite value $y$ as a linear combination of the individual composing values. These composing criteria values, $x$, may be either $-1$, $0$ or $1$. The coefficients $b$ in this combination are the *initially undetermined* weights of the composing values.

Then, based on Table 1, the three composite values are as follows:

$$
\begin{align*}
  y_1 &= b_1 + b_2 - b_4 - b_5 - b_6 - b_7 \\
  y_2 &= b_2 + b_3 + b_8 \\
  y_3 &= -b_1 + b_2 + b_3 + b_4 + b_6 + b_7 + b_8
\end{align*}
$$

Further assuming that all $b_i$’s are non-negative and that they add up to unity (i.e. the periods’ composite values are arithmetically weighted averages of the composing values), then:

$$b_2 = 1 - b_1 - b_3 - \ldots - b_8$$

It follows that:

$$
\begin{align*}
  y_1 &= 1 - (b_3 + b_8 + 2(b_4 + b_5 + b_6 + b_7)) \\
  y_2 &= 1 - b_1 - b_4 - b_5 - b_6 - b_7 \\
  y_3 &= 1 - 2b_1 - b_5
\end{align*}
$$

The EKC hypothesis holds if:

$$
\begin{align*}
  y_1 - y_2 &= b_1 - (b_3 + b_4 + b_5 + b_6 + b_7 + b_8) < 0 \\
  y_3 - y_2 &= -b_1 + b_4 + b_6 + b_7 > 0
\end{align*}
$$

or, equivalently, if (and only if):

$$b_1 < b_4 + b_6 + b_7$$

This result reduces the ambiguity concerning the existence of the EKC, leaving (in our case) only the following condition: it holds if the weight of the “deviant” indicator (the state of the water resource) is smaller than the combined weights of the “well-behaved indicators” (wastewater recycling, regulating Mediterranean coastal waters, rivers—administration and rehabilitation efforts).