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THE EFFECT OF SEQUENCING TRADE AND WATER MARKET REFORM ON INTEREST GROUPS IN IRRIGATED AGRICULTURE: AN INTERTEMPORAL ECONOMY-WIDE ANALYSIS OF THE MOROCCAN CASE

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Abstract

Many of the import competing sectors in Moroccan agriculture are protected while water in irrigated agriculture is priced below its marginal value product. Establishing a water market in this pre-trade reform environment can be welfare decreasing. Further, as the shadow price of water is sensitive to the crops protected by trade policy, farmers growing crops protected pre-trade reform can be made worse off post reform. The resulting decline in rents to sector resources is a source of interest group conflict that can slow the overall reform process. Using an intertemporal general equilibrium model, the paper analyzes the economy-wide effects of the linkages between trade reform and the reform of water markets in irrigated agriculture. We find a strong investment and growth response to the trade reform, and a reallocation of resources to the production of fruit and vegetable crops, for which Morocco has a strong comparative advantage. Trade reform is found to actually create an opportunity to introduce water pricing reforms. Creating a water user-rights market post trade reform not only compensates partially for the decline in rents to protected crops, but also raises the efficiency of water allocation and hence benefits the economy as a whole.

Key Words: Water Markets, Trade Reform, Dynamic General Equilibrium

JEL Classification: F13, O41, Q15, Q25

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Introduction

As a semi-arid region in the lower segment of middle-income category of countries, Moroccan economic policy continues to protect the import competing sectors through an array of tariff and non-tariff barriers in spite of having made substantial economic reforms dating to the mid 1980s (Doukkali 1997). Agriculture accounted for approximately 18.4 percent of GDP in 1994, 30 percent of export receipts, about 50 percent of the country's active population, and it consumes roughly 85 percent of the country's scarce supplies of mobilized water. Consequently, trade distortions can have deleterious consequences to the rural sector of the economy, and particularly to the efficient allocation of the country's water resources. The data complied by Doukkali (1997) from various sources suggest that tariff rates of about 50 percent were imposed on the imports of wheat and industrial crops while tariff rates were on vegetable and fruits averaged less than 7 percent. In addition, there exist various non-tariff barriers to agricultural trade. The tariff equivalent rate calculated by Doukkali (1997) for wheat and livestock ranged from 160 to 270 percent, respectively, of their total import values. Some sectors also received producer price subsidies. The subsidy rates on the producer price for wheat was equivalent to 28 percent of the gross value of wheat produced in 1994, and 3 percent for industrial crops.

According to a World Bank study (The World Bank 1986), Morocco enjoys a clear comparative advantage in the production of key irrigated exportables, such as fruits and vegetables. The protected wheat and industrial crops sectors use water intensively relative to the dis-protected crops, such as fruits and vegetables, thereby consuming water that could otherwise be allocated to the more profitable crops to further their comparative advantage in world markets. Depending on the country's water allocation policies and water development plans, correcting for these distortions has at least the short-run benefit of potentially reducing the pressure on water resources while leading to a more efficient pattern of water allocation among crops.

Morocco's water development plan entails increasing national water balances by constructing large and medium-scale dams to serve regional demands as well as the transfer of water between basins. Currently, ten of the largest dams among the 40 in existence carry 90 percent of the total volume of water flow. Surface flows account for approximately 75 percent (8.5 billion cubic meters, The World Bank 1995, p8) of total mobilized water supplies. As a major consumer of available water resources, the sector is targeted for technical and institutional reforms aimed at improving water use efficiency (Dinar et al. 1998). However, its progress in this direction has been slowed.

Water resource management is currently executed by nine Regional Agricultural Development Authorities (ORMVA) under the supervision of MAMVA. The water charge rate to farmers is generally viewed as only sufficient to cover operation and maintenance costs. As the water charge is below the price the marginal users are willing to pay (i.e., below the marginal value product of water), the distribution of water must be administered (The World Bank 1995, p25). When the "quota" of water obtained by farmers is below the demand for water at the given water charge rate, then, implicitly, a shadow price for water exists. Depending upon the marginal product of water allocated to various crops, this price will vary accordingly, even though the government charges the same price per volumetric of water (Tsur and Dinar 1995). The cost shares of water's contribution to the gross value of outputs produced in the irrigated sector are estimated by Doukkali,1997 to vary from 13 to 37 percent, while water charges administered by government account for only 8 - 24 percent of the gross value of outputs (Ministere de l'Agriculture et de la Mise en Valeur Agricole Administration du Genie Rural 1997, p4). The difference between the shadow price of water and the government's charge accrues as a benefit to the farmer. As the intensity of water use varies by crop, such benefits to farmers growing different crops vary from an estimated 5 to 13 percent of the gross value of the sectoral outputs.

Nature of the Problem and Objectives of the Paper

Protection of the import competing crops alters the pattern of employment of other agricultural and economy wide resources in their favor. Moreover, in an environment where irrigation water is priced below its shadow price so that it must be administratively allocated, raising water prices while leaving trade distortions in place may further tax, implicitly, the crops which trade policy discriminates against. On the other hand, in an environment where water allocation must be administered, reform which removes protection received by producers of the import competing crops may not induce the producers of these formerly protected crops to alter the pattern of water use, even though the use of other resources may fall. This situation can arise when, post trade reform, the new shadow prices of water in the now dis-protected crops remain positive, albeit lower than their prior values.

Many of the other effects of trade reform will have indirect but no less important benefits to agriculture. They include incentives for households to save a proportion of the increased income for investment, which of course increases the returns to other primary resources by expanding production possibilities over time. Growth in total exports also provides foreign exchange earnings to import more intermediate inputs at costs lower than would otherwise be possible from the local economy.

The first objective of this paper is to provide insights into the relative magnitude of these inter-linkages, and to assess how trade reform might affect the level and pattern of water allocation in irrigated agriculture. Particular attention is given to how this pattern evolves as the economy approaches a new long-run equilibrium.

The second objective is to ascertain whether reform of the country's water pricing regime might also have the effect of lowering the resistance to over-all policy reform. Aside from trade reform, the fact that the administered allocation of water results in varying water shadow prices across crops, in itself, raises the question as to whether producers of various crops and their associations vary in political influence. Moreover, water pricing and the political economy of water user-rights in irrigated agriculture are likely to become even more contentious if trade policy reform is pursued. Since, like most countries, sector specific resources are unevenly distributed among households, policy reform that alters the flow of rents to sector specific assets, including water rights, almost always benefits some at the cost of others even though the economy as a whole typically experiences a net welfare gain.

As mentioned above, when the water charge price is below water's marginal value product, there exists an implicit subsidy to farmers using irrigation water. This implicit subsidy is usually higher for the protected crops. Such benefits are equivalent, approximately, to the difference between water's shadow price and government charge price. Since policies favoring the import competing sectors have been in place for an extended period of time, farmers producing crops protected by the old policies will, at the margin, be made worse of as the returns to the resources specific these crops, including their water quota, fall, at least in the short run. Returns to other crop specific resources may also fall. These include farmers' investment in skills and expertise at growing crops such as sugar beets and sugar cane, land suitable for growing irrigated cereals but not easily shifted to growing vegetables in the short run, and tree crops which typically require several years before the fruit can be profitably harvested. If, in addition to trade reform, the government either re-distributed the water "quota" according to the post-trade reform's crop growing plan or raised the water charge price, then the returns to the relatively crop specific resources of those farmers who grow the formerly protected crops would be further depressed. It is individually and often interest group rational for the growers of the protected crops to resist reform, and to resist the reallocation of water quotas to the more profitable crops. This source of conflict often becomes a major stumbling bloc to the entire policy reform process.

However, political resistance to trade reform and to the reform of water pricing may be lowered if the decline in returns to the formerly protected crops can be at least partially counter-balanced by some other scheme. Thus, the second goal is to evaluate the potential of a water rights pricing scheme that may be made possible by economy-wide trade reform which can counter-balance these losses while also leading to a more efficient allocation of water among crops. The establishment of a water rights market could potentially provide such a mechanism. The scheme we investigate is a water rental market where water user-rights can be traded among farmer in irrigation sector, while the ownership of the user-right is based on a farmer's historical pre-reform allotment of water (or water quota).

The analysis is based on an intertemporal general equilibrium model developed by Diao and Somwaru (1997), and draws in many ways upon the recent contributions of dynamic CGE modeling by Ho 1989; McKibbin 1993; Mercenier and Sampaïo de Souza 1994; Go 1994; Diao et al. 1998. We utilize the model to simulate both the short- and the long-run transitional dynamic effects of trade reforms and a water-user rights market in the context of a whole economy. The model is dynamic in the sense that firms and households make intertemporal optimization decisions, i.e., forward looking behavior, such that a change in trade policy and water price policy will affect savings, investment, and capital accumulation activities of the economic agents modeled. The focus of the study is agriculture, especially the irrigated agricultural sector. However, a change in non-agricultural trade policies also affects agriculture through changes in relative prices, allocation of resources, and investment decisions. Hence, the model is built as a general equilibrium model, i.e., all economic activities, including the non-agricultural sectors, consumers and government consumption, are included in the model.

Plan of the Paper and Principle Findings

The paper is divided into four main sections. In Section II, a brief overview of the inter temporal general equilibrium model is presented followed by a discussion of the data. Section III discusses the short- and longer-run effects of trade reform alone, with emphasis on agriculture and the irrigation sector in particular. We find a strong investment and growth response to reform, and a reallocation of resources to the production of fruit and vegetable crops. The shadow price of water rises in some sectors but falls in the others. Hence, from a political economy perspective, it is rational for the farmers in a sector in which the water shadow price falls to resist trade reform. In Section IV, we analyze the opportunity provided by trade reform to establish a water user-rights market which, at the same time, at least partially compensates those who might otherwise resist both economy-wide and water policy reforms because of the decline in their real income that reform would cause. We find that allowing farmers to rent in or out water user rights leads to further economic efficiencies that can even be detected at the national level, while at the same time, mitigating the post-reform decline in income of those producers producing the pre-reform protected crops.

Overview of the Methodology and Data

The model is based on inter temporal general equilibrium theory with a multi-sector specification. For the purpose of the study, the Moroccan economy is aggregated into 20 production sectors, including 6 irrigated agricultural sectors, 6 rainfed agricultural sectors, 4 agriculturally related sectors and 4 nonagricultural sectors. There are 6 commodities produced by the agricultural sectors (Table 1). The description of the economic agents' behavior in the model and the data are as follows:

Firms and Investment

We assume that the representative firm (or farmer) in each sector operates with constant returns to scale technology. The representative firm chooses at each time period the quantities of inputs and level of investment to maximize the value of the firm. Inputs are labor, capital, land, water, and other intermediates, while the investment inputs are forgone final goods produced domestically plus imports. The value added production function is of Cobb-Douglas form, while the intensities of intermediate goods are fixed. Labor and capital are classified as agricultural (including rural services) and non agricultural. Overtime, sectoral capital accumulates while the other factors of production are permitted to re-allocate within the agricultural and non-agricultural sectors, but not between sectors. For example, agricultural labor can be reallocated among the various production sectors in agriculture, but migration to the non-agricultural sectors is not permitted, and likewise for urban labor and capital. Land is classified as irrigated and non-irrigated. Irrigation water is initially controlled and distributed by the government who collects a water charge from farmers in the irrigated sector. Because of data constraints, the use of water by the urban sector is omitted from the analysis.

Firms are presumed to finance investment outlays by retaining profits so that the number of firm equities within the economy remains unchanged. The non-arbitrage condition derived from the first order condition of the firm's profit maximization implies

$$wk_{i,t} + \phi_i PI_{i,t}\left(\frac{I_{i,t}}{K_{i,t}}\right)^2 + (1-\delta_i)q_{i,t} - (1+r_t)q_{i,t-1} = 0$$

where $wk_{i,t}$ is sectoral marginal product of capital; Tobin's $q_{i,t}$ is the shadow price of capital; $K_{i,t}$ is sectoral capital stock; $PI_{i,t}$ is value of per unit of investment goods; $I_{i,t}$ is quantity of sectoral physical investment; δ is physical capital depreciation rate; r_t is interest rate, and $\phi_i PI_{i,t}(I_{i,t}/K_{i,t})^2$ denotes the installation/adjustment cost per unit of capital.

The output of each sector, except for the sectors of rural services and public administration, can be exported abroad or consumed domestically.

Households and Consumption/Savings

Households behave as extended immortal families. They are aggregated into two groups: rural and urban. Rural households own agricultural labor, capital, and land. Urban households own non-agricultural labor and capital. The representative household makes consumption and saving decisions to maximize an inter-temporal utility function. The Euler equation derived from the first order condition of utility maximization implies that the marginal utility across two adjacent periods satisfy the following condition:

$$\frac{u'_{t+1}(1+\rho)^{-1}}{u'_t} = \frac{Ptc_{t+1}(1+r_{t+1})^{-1}}{Ptc_t} \qquad (1)$$

where u_t' is the derivative of the instantaneous felicity function, u_t, at time t with respect to the aggregate consumption Q_t, generated from the thirteen final goods; ρ is positive and represents the rate of time preference; and Ptc_t is the consumer price index. Equation (1) implies that the marginal rate of substitution between consumption at time t and t+1 is equal to the ratio of the consumption price index at time t and t+1. A sequence of aggregate household consumption and savings are determined simultaneously from Eq. (1).

Demand for final goods (including demand by private households, the government, the firms as intermediate inputs and investment inputs) is satisfied by domestic production and imports, and with the famous Armington Assumption (Armington 1969), domestic goods and imported goods are imperfect substitutable.

Government Policies

The government intervenes in the economy using host of instruments: taxes and subsidies, import tariffs, indirect taxes on producers, households taxes/subsidies, producer support price subsidies, and non-tariff barriers. The government is also presumed to impose a water charge by the method of volumetric pricing. All policy variables are exogenous.

The Data

Data on sectoral outputs and inputs, household and government consumption, investment, exports and imports, as well as levels of various taxes and subsidies are obtained from a Social Accounting Matrix of Morocco developed by Doukkali, 1997. The data represents the Moroccan economy in 1994, including the various levels of interventions mentioned above. The data on irrigated areas, water consumption by crops and so on were obtained by Doukkali from the annual reports of ROIs to the central administration supervising irrigation (Department of Rural Engineering), from this department's own estimates as well as from other departments of the Ministry of Agriculture. The authors then compared these estimates with data available from other studies of the irrigation sector conducted by international and national organization (FAO 1982, 1985, 1986 and 1987; The World Bank 1995).[1] The share of water charges to the gross value of output were calculated from a table in Section 3, p4, of Ministere de l'Agriculture et de la Mise en Valeur Agricole Administration de Genie Rural (1997).

[1] All of these are done by Doukkali 1997.

The Effects of Trade Reform on the Economy

In this analysis, total reform is presumed, i.e., all import tariffs, non-tariff barriers, as well as producer price supports are eliminated.[2] As the main purpose of the study is not to focus on the trade liberalization per se, we do not model the process of the reform, e.g., which policy should change first and by what magnitude. These are the subject of a future paper focusing on growth and growth externalities.

Trade liberalization will cause sectoral production, capital investment, consumption and savings, and trade to adjust. Since the model is dynamic, these adjustments take time, which allows us to estimate both the short- and long-run effects of reforms. During the adjustment process, the demand for water, and the shadow price of irrigation water also change. Hence, the political economy of water issue is likely to arise as a result of the trade reform. Such effects come not only from changes in producer prices, but also from lowered returns to the water "quota" common to those sectors at their respective pre-reform volume. As we mentioned above, when the water charge price is below the marginal product of water, there exists an implicit subsidy to farmers who use irrigation water. Such benefits are equivalent, approximately, to the difference between water's shadow price and government charge price. If the government further reduced the water "quota" for those farmers who grow the crops protected pre-reform, those farmers would be further hurt by the reform.

To capture the economy-wide as well as sectoral effects of the trade reform, we first fix the water "quota" allocated to different sectors at the level given by the data, i.e., we first ignore the possible effects caused by water quota redistribution on farmers who grow different crops. While irrigable land can be allocated to different crops within the sector by its owners, land cannot be reallocated instantaneously. Thus, we allow the land allocation cross irrigable crops to require time to fully adjust, with about a 5 year lag after the trade reforms take place. This assumption is based on the fact that some resources are sector/crop specific, such as land and farmers' investment in skills and expertise at

[2] This analysis also abstracts from the country's historical rates of growth in total factor productivity.

growing specific crops. Hence, growers of sugar beets or sugar cane cannot easily switch to growing vegetables or fruits in the short run.

Economy-Wide Effects of Trade Reform: Welfare Gains and Income Growth

The results show a strong economy-wide growth effect from the removal of the trade distortions and subsidies. Post reform, the country's GDP increases by 2 percent in the short-run, rising to 10 percent in the long-run (Figure 1), relative to the status quo. Social welfare, in the money metric of *equivalent variation,* rises by 4 percent.[3] Households in the rural area benefit more than those in the urban area, in part, because we assume that the government obtains, in lump sum, taxes on urban households to cover the revenue loss from tariffs.[4] The real income for rural households as a group rises by 5 percent in the short-run and 14 percent in the long-run (Table 2).

Perhaps more importantly, the economy-wide gains from reform mainly accrue from two sources: efficiency gains from the allocation of resources to more profitable activities, and the more rapid accumulation of capital due to the more profitable investment alternatives. The growth in the stock of capital not only increases wealth, but it also raises the rental rates of primary resources, such as land and water, and labor.

Interestingly, the urban - rural effects of reform on capital accumulation are not symmetric (Figure 2). Urban investment rises sharply almost immediately after the reform takes place, while rural investment in the first three years is not sufficient to replace depreciated capital, but subsequently, rises in the medium and long-run. In the long-run, the growth in investment results in capital stocks that are larger than base stocks by 26 and 12 percent in the urban and rural sectors, respectively. The major reason for this pattern is that the non-farm sector is relatively more distorted than the farm sector. Tariffs on non-farm import competing goods averaged about 28 percent, and about 19.5 percent on export competing goods. Tariffs on sugar products and processed food were 54

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[3] This measure was derived by Mercenier and Yeldan 1997, and is based on the household's inter-temporal utility function.

[4] Of course, this assumption has no affect on the allocation of resources.

percent and 23 percent, respectively. The initial decline and then growth in capital stock in the rural sector reflects the effects of the lag required in shifting land from the production of the protected crops into the production of, primarily, other cereals, fruits and vegetables and, at least initially, the relatively more profitable investment opportunities in the non-farm sector. Of course, these investment opportunities induce households, in the short-run, to forgo some consumption thus causing a decline in their demand for goods and services.

Agricultural laborers as a group, as well as land owners, benefit from reforms. In the long-run, the agricultural real wage rate rises by 16 percent, while returns to irrigated land rises by 14 percent and 9 percent for other lands (Table 2). However, the increase in the agricultural wage rate is still lower than that of non-agricultural wage (which rises by 25 percent) due in part to the relatively larger increase in the urban capital stock. The widened rural-urban income gap is likely to place further pressures on labor migration out of primary agriculture and into rural non-farm and urban enterprises. The relative shortage of labor in the non-farm sector limits the competitiveness of its traded goods in world markets.

Eliminating trade protection stimulates the country's trade, both imports and exports rise, but total exports rise more than the increase in imports by 4 percentage points in the short-run and 8 percent points in the long-run (Figure 1). The change in sectoral exports and imports is summarized in the "Without water user-right market" panel of Table 4.

Sectoral Effects of Trade Reform: Some Gain and Some Lose

Trade reform, (eliminating tariff and non-tariff barriers and the abolishment of producer price supports) changes relative prices faced by producers. Farmers producing protected crops are made worse off, post reform, as they face lower relative output prices and the gross value of their output falls. Other sectors benefiting from reform compete for the inputs of agricultural labor, capital and other intermediate inputs, causing the rental rates of many of these inputs to rise. These two forces working together, lower the returns to the relatively crop specific factors of production in the formerly protected sectors. Our simulation results (Table 3) suggest that in the short and intermediate run, the returns to irrigated land, normalized by consumer price index, falls for wheat, especially soft wheat, but rises for the other crops. The result is not surprising as wheat production was highly protected by tariffs and non-tariff barriers.

Changes in the return to land encourage farmers to adjust, with a lag, their cropping pattern. In the simulation, we allow the readjustment of land to occur over a five year interval. In the real economy, the period of adjusted may be more crop dependent, with some land never being reallocated to other crops. Hence, the simulation should be viewed as providing an upper bond to land adjustment. From such a "best case" adjustment, returns to irrigated land rise by 11 percent in the first 10 years and 15 percent in the long-run.

Effects on Sectoral Water Shadow Prices: Some Rise and Some Fall

Given no change in the government's water pricing and distribution policy, reform causes the returns to farmers' water "quota" to change by relatively large and differing magnitudes. As discussed previously, since the water charge rate is lower than the price that the marginal user of water is willing to pay, the excess demand for water has to be constrained by the government's distribution policy. Hence, a water shadow price is associated with each water "quota." The difference between the water shadow price and government charge is equivalent to the rent farmers earn from the water "quota". In the first simulation, trade liberalization causes the shadow price of the water "quota" for soft wheat production to fall over the entire horizon required to reallocate some (not all) land from soft wheat to other crops, and to decline for the case of hard wheat in the short-run (bottom panel, Table 3). In other sectors, the shadow price of water rises with the magnitude of change varying cross sectors, ranging from a high of more than 20 percent for the case of vegetable and fruits to a low of less than 10 percent for the case of industrial crops. After the five year adjustment, the shadow price of land equilibrates across crops (top panel, Table 3).

It is obvious that a close link exists between changes in the sectoral shadow price of water and rates of trade protection. The data show that, pre-reform, wheat production is highly protected while vegetable and fruits are less protected. When tariff and non-tariff trade barriers are removed, and producer support price policies are abolished, the country's comparative advantage in the production of vegetable and fruits can be more fully realized. This increases the derived demand for water and willingness to pay for water in these sectors. On the other hand, the loss of protection to the producers of irrigated wheat and industrial crops cause their production to fall (top panel, Table 5). The producers of these commodities also experience a concomitant decline in the returns to the water use-rights they held from the government's distribution policy.

Generally speaking, as any policy reform almost always affects somebody's interest negatively, the most difficult task in the reform processes is to find a feasible way to compensate and hence to reduce the resistance of interest groups hurt by the reform. The results from the first simulation have two important implications in this regard. First, farmers producing the pre-reform protected crops are "doubly hurt" due to a lower output price and a lower water shadow price. Farmers producing the dis-protected crops gain, but could gain potentially more if the water "quota" is redistributed. That is, if, post-trade reform, the government reduces the water "quota" to farmers of the formerly protected crops in proportion to the fall in their production, they are made even worse off although water would be allocated more efficiently. In principle, it is individually rational for these producers to resist such reforms. Second, the changes in water shadow prices caused by trade reform create an opportunity to form a water user-rights market. In this case, we envision nothing more than giving farmers entitlement to their pre-reform water user's rights, that is, the right to earn the market rents from their historical water "quota".

There are two major benefits from allowing farmers whose production falls, post reform, to rent out some (not all) of their water user-rights. Renting out some of their water use-rights reduces the post reform costs faced by farmers whose incomes are hurt by reform, and hence a tendency to reduce the political resistance to reform. Second, creating a water user-rights market should also increase the efficiency of water allocation, yielding benefits to the whole economy by providing incentives for the better husbandry of Morocco's scarce water resources.

The Moroccan government has faced difficulties and encountered delays in its efforts to improve water use efficiency. A reason is that the government's water supply organizations (ORMVAs) are apparently reluctant to accept more responsibility in developing the country's water resources without any additional compensation (Dinar et al. 1998). Also, when the benefits from pricing water below its opportunity cost become embodied in the value of the land or other factors, it is politically very difficult for virtually any government to charge and collect water revenues commensurate with either its actual cost or its opportunity cost.

The creation of water user-rights market may not generate revenue for the government in the short term. Nevertheless, the existence of such a market, in which transactions among farmers makes explicit the rental price of water, should eventually separate the returns to water from that to the land. This in turn should make further reform in water prices relatively easy, such as the imposition of a water tax to help defray the public costs of water mobilization and distribution. A water user-rights market should eventually allow water to be treated as a normal commodity, providing private agents with greater incentives to invest in the maintenance of water sector capital and to better husband this resource.

Win-Win Outcomes from Creating a Water User-Rights Market

In the second scenario, in addition to trade reform, farmers within each irrigated sector are allow to rent in or out in their water user-rights. Farmer's entitlement to water user-rights are assumed to be determined by the water quota allotted them by the government according to the farming practices in the pre-reform period. The rental price is set at the market clearing shadow price for water and is solved simultaneously with all other endogenous variables in the model. Of course, there exists numerous adjudication, technical and practical problems in forming a water market, many of which are discussed by Thobanl (1997). While these very real problems are ignored here, the simulation nevertheless provides empirical insights into the relative nature of the possible gains from such a water market pricing scheme.

The results show clearly that allowing farmers to rent their water user-rights to others, not only increases the efficiency of water use, but also compensates them partially for the loss suffered in the production of the pre-reform protected commodities.

Gains from a Water User-Rights Market: Counter-Balancing Post Reform Losses

The trade in water user rights among farmers in the perimeter causes some (not all) water to be allocated away from crops yielding a relatively low return (i.e., low shadow price). Since water is now paid its full marginal value product, the level of total water use can also change. Simulation results show that there are two sectors in which water consumption increases: other cereals (exclusive of wheat) and vegetable and fruits. Water consumption in the other three sectors, soft wheat, hard wheat and industrial crops, falls (Table 7). This change in water consumption is consistent with the economy's post-reform comparative advantage.

The producers of soft wheat earn income by renting some (not all) of there water user-rights to producers producing, post refrom, more profitable crops. This causes a decrease in their production of soft wheat (table 5), and a releasing of some labor and other resources for employment in the more profitable crops. However, even in this open economy, the decline in supply of the formerly protected crops causes the producer prices of these crops to rise (bottom panel, table 6). This occurs because domestic wheat is not a perfect substitute for imported varieties. Table 6 shows that without a water market, relative to the base period, the post trade reform producer price of soft wheat falls by more than 20 percent in the short-tun, and more than 5 percent in the medium- and long-run. The establishment of a water user-rights market and the subsequent decline in the production of soft wheat causes the price of soft wheat to fall by less than one percent in the first year and then to rise about one percent in the long-run, relative to the base. A similar result is observed for the price of industrial crops.

Of course, the decline in domestic supply of soft wheat and industrial crops, and the resulting excess demand for these commodities is partially satisfied by imports. This result is shown by the rise in imports of soft wheat and industrial crops in the short- and medium run (bottom panel, table 4). In the long-run, exports exceed the value of imports by the amount required to service the country's foreign debt.

Trade and water market reform still results in a decline in the gross value of the outputs of wheat and industrial crops (table 8). The simulation results show that returns to land fall less in the first 5 years and increase there after when a market for water user-rights exists (upper right panel of table 3). This result indicates that the revenue loss to the growers of wheat and industrial crops is partially compensated for by the increase in the returns to the irrigated land as well as revenues earned in renting out water. For the growers of wheat and industrial crops, the major compensation, of course, accurse directly from the rental income to the farmer's entitlement to the water user rights.

These values are shown in Table 9. We use the difference between the two levels of water shadow prices, before and after water right trading is permitted, i.e., we use the implicit rental value given by the unit gain/loss for each volume of water rented in/out by farmers, and then multiply this value by the traded volume of water to obtain the total gains/losses for each sector. The volume is the sectoral water "quota" given by the data, minus the same sector's water consumption after water trading is permitted. As some sectors are more aggregated, and hence use more water, to report the absolute value of the gains may be misleading. Thus, the gains/losses from water sales are compared (in percent terms) with the returns to water in the base data, pre-trade reform and water marketing. To make this more clear, consider the following example. The result that growers of soft wheat gain 19.02 percent from renting their water user-rights to others, implies that, in comparison with the returns they received implicitly from the shadow price of their water "quota" pre-reform, an additional 19 percent of revenue can be generated from renting some of their water "quota" to the growers of other crops.

Three sectors, soft wheat, hard wheat and industrial crops, rent out water over the entire time period. We see that (from the bottom panel of Table 9) the rents earned amount to a relatively large gain for soft wheat growers (19 - 13 percent) and a smaller gain (about one percent) for growers of hard wheat and industrial crops. Even though the shadow price of water for some sectors does not fall post reform, growers in these sectors still gain directly from renting in water (i.e., from paying the water user-right rental fees to the original owners in the wheat and industrial crop sectors). The results show that only the growers of vegetables and fruits rent in water for the entire period, while growers in the other cereal sectors rent in some water in the long-run, i.e., as capital accumulation occurs.

Why are the growers of vegetable and fruits willing to pay the rental charges for the additional water? The reason is that with a fixed water "quota," the shadow price of water in these sectors is much higher, post-reform, than the market clearing price for water if traded (Table 3). This implies that the growers in these sectors are willing to pay a high rental price for water in order to earn greater returns to their resources. As the rental rate paid by the growers of vegetable and fruits is lower than the shadow price of the post-reform quota, the growers paying the water rental charges still benefit from such trading.

It should also be noted from table 3 that a water market has positive long-run effects on the rental rates of irrigable lands, and on rural wages since the more efficient use of water increases the marginal product of rural labor employed in the fruit and vegetable sectors. This lessons the gap between urban-rural wages as the urban wage rate remains virtually unchanged post-water market. Returns to other non-irrigable land falls slightly, post water market. The reason is that the irrigated sector becomes more competitive due to the more efficient use of water, and hence, competes with the non-irrigated sectors for agricultural labor and capital. However, in contrast to the status quo, returns to non-irrigable land are still significantly higher than the corresponding pre-reform rates. This result suggests that the negative effects of a water market on the non-irrigation sector is quite small and hence there is less reason for any political resistance to reform from that sector.

Thus, creating water rental markets among the farmers is, post trade reform, a "win-win" strategy, as almost all farmers and farm labor benefit, and water resources are allocated more efficiently. However, in the real economy, there are surely the mentioned transaction costs of forming such a market, costs which are not taken into account here.

Conclusion

In spite of significant policy reforms, the import competing sectors of the Moroccan economy tend to be heavily protected while water is priced below its marginal value product in irrigated agriculture. Agriculture, employs about 50 percent of the country's work force and consumes approximately 85 percent of her total water resources. Consequently, the efficient allocation of her water resources are not only dependent on water pricing and distribution policies within agriculture, but also on her foreign trade, producer price support, and indirect tax policies. In the absence of trade reform, however, abandoning the administrative allocation of water quotas in favor of a more market driven water allocation scheme could be welfare decreasing because water could well be allocated in the direction of the protected crops.

Within this context, an inter-temporal general equilibrium model is used to analyze the economy-wide effects of trade reform as well as the effects on the different irrigated agricultural sectors. We find a strong investment and growth response to trade reform, and a reallocation of resources to the production of fruit and vegetable crops, for which Morocco has a strong comparative advantage. Trade reform causes the shadow price of water to rise for the case of fruits and vegetables crops relative to the pre-reform protected crops. The change in returns to sector specific assets caused by reform is likely to induce interest group conflicts since reform causes some farmers growing crops protected pre-reform to be made worse off post reform. On the other hand, trade reform may create an opportunity to introduce water pricing reforms because farmer's made worse off post reform, can earn income from renting out some of their water to others. The results suggest that creating a water user-rights market not only compensates partially for the losses of farmers made worse off, post trade reform, but also raises the efficiency of water allocation and hence benefits the economy as a whole.

As the government water charge rate in Morocco is far below its real costs (taking into account investment costs of water mobilization), and below its opportunity cost, it is almost politically impossible for the government to charge and collect water revenues commensurate with either the actual marginal cost of water or its opportunity cost. This is particularly the case when the benefits of a low water charge has been in existence for such a long period of time that the value of water's shadow price becomes embodied in the value of the land or other factors of production. Even though the creation of water user-rights market may not generate revenue for the government in the near term, such a market reveals to all the opportunity cost of water which should, eventually, separate the returns to water from that to the land. This in turn should make further reform to help defray government costs, such as imposing water price tax, or a property tax on a farmer's water right entitlement, relatively easy. Furthermore, a water user-rights market should eventually cause water to be treated like any other normal good, and private agents incentives to invest in the water sector and to better husband this scarce resource.

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Table 1. Sectors and Commodities in the Model

Sectors	Commodities
Irrigated soft wheat	Soft wheat
Rainfed soft wheat	
Irrigated hard wheat	Hard wheat
Rainfed hard wheat	
Irrigated other cereal	Other cereal
Rainfed other cereal	
Irrigated vegetable and tree fruits	Vegetable and fruits
Rainfed vegetable and treefruits	
Irrigated industrial crops	Industrial crops
Rainfed industrial crops	
Livestok in irrigated area	Livestock
Livestok in rainfed area	
Forest	Forest
Food processing industries	Processed foods
Sugar industry	Sugar and sugar products
Rural services	Rural services
Export-oriented manufacturing	Export-oriented manufacturing products
Impor-competing manufacturing	Import-competing manufacturing products
Services	Services
Public administration	

Figure 1:

Effects of Trade Reform on Total Trade without Water Rights Market

% deviation from the status quo

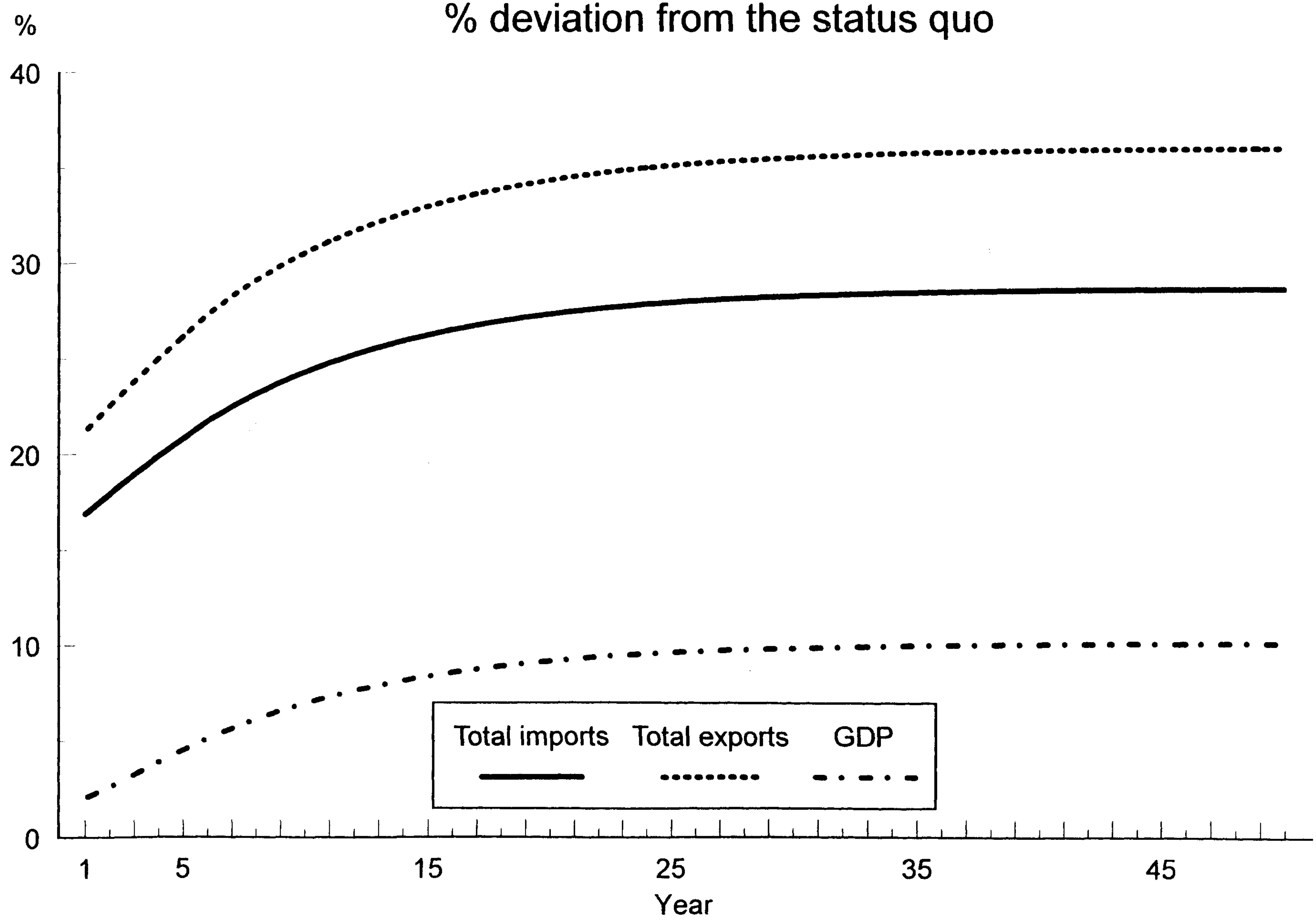
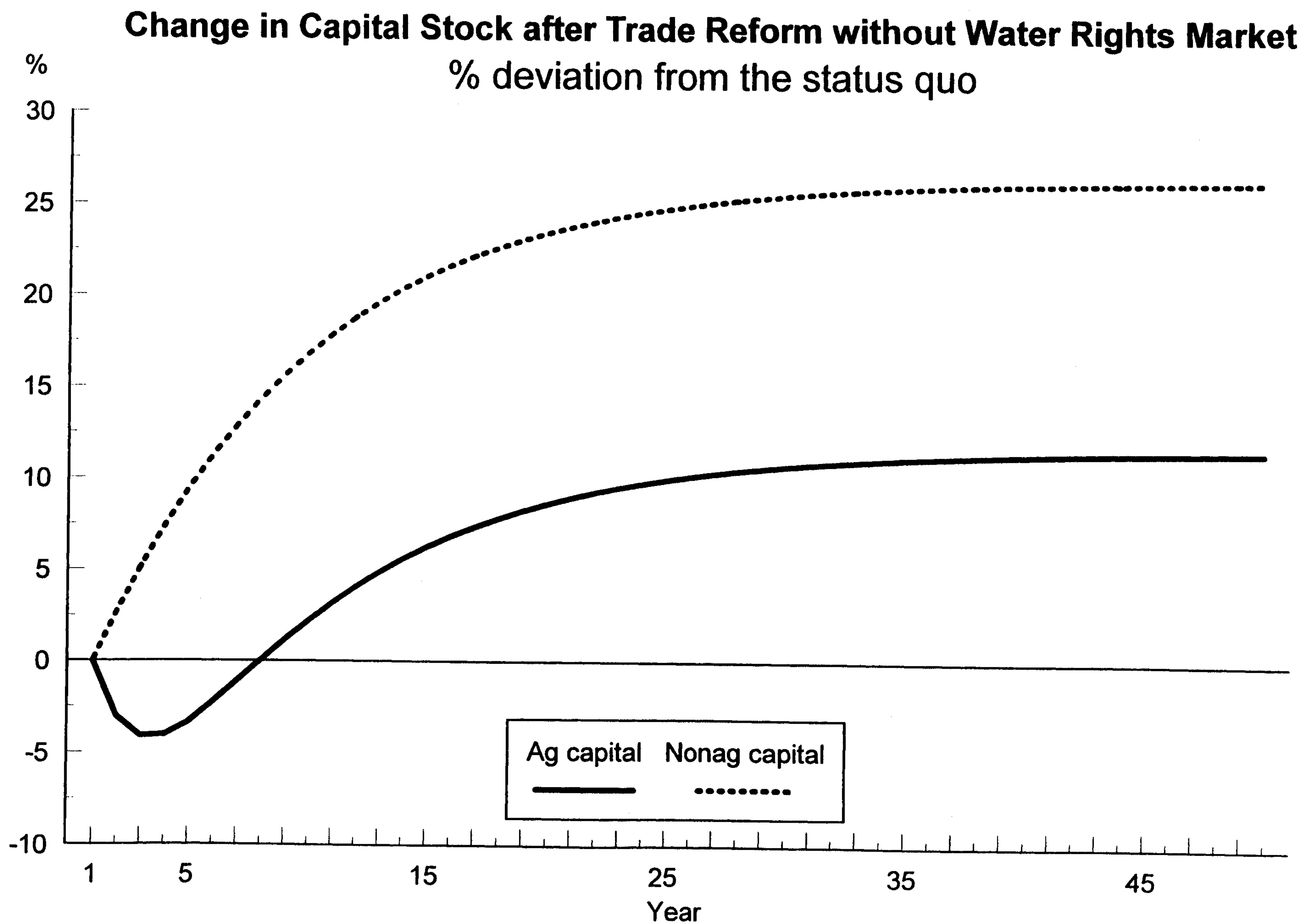


Figure 2:



Change in Capital Stock after Trade Reform without Water Rights Market
% deviation from the status quo
%
30
25
20
15
10
5
0
-5
-10
1
5
15
25
35
45
Year
Ag capital
Nonag capital

Table 2. Effects of Trade Reform on Welfare and Income in the Simulations

% change from the status quo

	Without water user-rights market				
	Year 5	Year 10	Year 15	Year 20	Steady states
Rural total income	5.58	7.5	9.57	10.85	12.49
Urban total income (1)	-5.25	-2.26	-0.54	0.42	1.59
Equivalent Variation (2)					3.91
	With water user-rights market				
	Year 5	Year 10	Year 15	Year 20	Steady states
Rural total income	5.27	8.61	10.84	12.17	13.86
Urban total income (1)	-5.32	-2.31	-0.59	0.37	1.56
Equivalent Variation (2)					3.92

(1) As government budget is assumed to be balanced at the base level, reduced tariff revenue is covered by household taxes on the urban households, which lowers urban income.

(2) Takes into account both transitional effects and steady state (long-term) effects, and gives current effects more weights.

Table 2. Effects of Trade Reform on Welfare and Income, With and Without a Water Market

% change from the status quo

	Without water user-rights market				
	Year 5	Year 10	Year 15	Year 20	Steady states
Rural total income	5.58	7.5	9.57	10.85	12.49
Urban total income (1)	-5.25	-2.26	-0.54	0.42	1.59
Equivalent Variation (2)					3.91
	With water user-rights market				
	Year 5	Year 10	Year 15	Year 20	Steady states
Rural total income	5.27	8.61	10.84	12.17	13.86
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(1) As government budget is assumed to be balanced at the base level, reduced tariff revenue is covered by household taxes on the urban households, which lowers urban income.

(2) Takes into account both transitional effects and steady state (long-term) effects, and gives current effects a higher weight.

Table 3. Effects of Trade Reform on Wage Rates, Returns to Land and Water Shadow Price, With and Without a Water Market

% change from the status quo and deflated by the consumer price index

		Without water user-rights market				*With water user-rights market*			
		Year 1	Year 5	Year 10	Steady State	Year 1	Year 5	Year 10	Steady state
Agricultural wage		9.12	8.24	11.56	16.01	9.29	8.49	11.76	16.16
Returns to irrigated land									
Growing	Soft wheat	-37.27	-34.75	11.44	14.72	-33.16	-31.64	12.36	15.34
	Hard wheat	-1.68	1.40	11.44	14.72	-0.38	2.40	12.36	15.34
	Other cereals	9.82	10.95	11.44	14.72	10.36	11.34	12.36	15.34
	Vegetable and fruits	20.89	20.34	11.44	14.72	22.07	21.45	12.36	15.34
	Industrial crops	5.79	6.38	11.44	14.72	4.28	4.99	12.36	15.34
Other land rents		-1.83	0.53	3.86	8.69	-1.95	0.45	3.79	8.66
Shadow price for water						11.24	11.58	14.93	18.26
Used by	Soft wheat	-37.27	-34.75	-25.36	-22.23				
	Hard wheat	-1.68	1.40	6.44	11.46				
	Other cereals	9.82	10.95	15.79	23.33				
	Vegetable and fruits	20.89	20.34	22.95	25.02				
	Industrial crops	5.79	6.38	6.46	8.00				
Non agricultural wage		16.33	19.63	21.76	24.52	16.27	19.57	21.71	24.50

Table 4. Effects of Trade Reform on Sectoral Imports and Exports, With and Without a Water Market

% change from the status quo

	Without water user-rights market					
	Year 1	Year 5	Year 10	Year 15	Year 20	Steady State
Exports						
Wheat	24.06	19.10	3.64	1.28	-0.03	-1.67
Other cereals	34.88	29.51	21.56	17.48	15.22	12.46
Industrial crops	36.24	30.98	20.10	15.60	13.15	10.18
Vegetable and fruits	23.95	22.81	22.44	19.08	17.19	14.87
Livestock	26.53	23.06	22.17	22.57	22.78	23.01
Imports						
Wheat	116.66	122.74	131.35	135.86	138.40	141.58
Other cereals	22.33	25.58	30.80	34.03	35.87	38.19
Industrial crops	16.82	18.66	22.93	25.48	26.94	28.77
Vegetable and fruits	0.35	0.44	3.41	5.10	6.07	7.29
Livestock	108.90	113.10	119.53	123.35	125.50	128.20

	With water user-rights market					
	Year 1	Year 5	Year 10	Year 15	Year 20	Steady states
Exports						
Wheat	15.84	11.77	0.54	-1.17	-2.97	-4.56
Other cereals	34.33	29.07	21.41	17.63	15.54	12.94
Industrial crops	32.36	29.07	13.55	9.04	6.58	3.60
Vegetable and fruits	28.47	26.81	26.19	22.52	20.47	17.93
Livestock	25.96	22.67	21.98	22.53	22.87	23.22
Imports						
Wheat	117.18	123.32	131.20	136.34	138.89	142.08
Other cereals	22.34	25.62	30.79	33.96	35.76	38.03
Industrial crops	16.94	18.85	23.31	25.88	27.36	29.20
Vegetable and fruits	0.53	0.67	3.62	5.29	6.25	7.46
Livestock	108.92	113.19	119.62	123.43	125.58	128.28

Table 5. Effects of Trade Reform on Sectoral Outputs of Irrigated Agriculture, With and Without a Water Market

% change from the status quo

	Without water user-rights market					
	Year 1	Year 5	Year 10	Year 15	Year 20	Steady State
Soft wheat	-17.74	-17.30	-26.17	-25.15	-24.59	-23.89
Hard wheat	-3.06	-2.67	-2.77	-1.50	-0.80	0.08
Other cereals	0.43	0.62	2.54	3.67	4.30	5.10
Industrial crops	-1.02	-0.80	-2.81	-3.12	-3.30	-3.53
Vegetable and fruits	5.22	5.18	7.83	7.34	7.07	6.75
	With water user-rights market					
	Year 1	Year 5	Year 10	Year 15	Year 20	Steady State
Soft wheat	-33.21	-31.91	-30.18	-29.14	-28.57	-27.85
Hard wheat	-7.81	-6.31	-4.03	-2.64	-1.86	-0.89
Other cereals	0.06	0.55	2.68	4.08	4.87	5.85
Industrial crops	-7.59	-7.03	-7.52	-7.89	-8.11	-8.37
Vegetable and fruits	12.27	11.41	10.22	9.54	9.16	8.71

Table 6. Effects of Trade Reform on Producer Prices for Irrigated Agriculture, With and Without a Water Market

% change from the status quo

	Without water user-rights market					
	Year 1	Year 5	Year 10	Year 15	Year 20	Steady State
Soft wheat	-22.59	-20.96	-6.43	-6.17	-6.03	-5.85
Hard wheat	-4.55	-2.83	0.71	1.22	1.52	1.89
Other cereals	1.68	2.39	4.54	6.12	7.04	8.19
Industrial crops	-2.15	-2.05	-0.74	-0.16	0.17	0.60
Vegetable and fruits	1.15	0.88	0.63	1.34	1.76	2.29
	With water user-rights market					
	Year 1	Year 5	Year 10	Year 15	Year 20	Steady State
Soft wheat	-14.28	-12.96	0.42	0.57	0.66	0.78
Hard wheat	-2.21	-0.96	2.28	2.63	2.83	3.09
Other cereals	2.33	2.74	4.47	5.38	5.92	6.60
Industrial crops	-1.23	-1.22	1.18	1.88	2.30	2.82
Vegetable and fruits	0.06	-0.08	-0.25	0.50	0.94	1.50

Table 7. Change in Water Consumption by Crops in Irrigated Agriculture after Allowing for Trade in Water User Rights

% change from the status quo

	Year 1	Year 5	Year 10	Steady States
Soft wheat	-39.21	-37.84	-32.27	-31.51
Hard wheat	-10.44	-8.23	-6.66	-5.19
Other cereals	10.79	-0.22	0.82	3.36
Industrial crops	-6.36	-5.91	-9.34	-10.44
Vegetable and fruits	9.74	8.84	7.88	6.42

Table 8. Change in Gross Value of Sectoral Outputs in Irrigated Agriculture after Allowing for Trade in Water User Rights

% change from the status quo

	Year 1	Year 5	Year 10	Year 15	Year 20	Steady State
Soft wheat	-33.66	-31.83	-29.90	-28.74	-28.09	-27.29
Hard wheat	-6.72	-4.70	-1.84	-0.08	0.92	2.17
Other cereals	2.92	3.70	7.27	9.68	11.07	12.83
Industrial crops	-7.49	-6.88	-6.43	-6.16	-6.00	-5.78
Vegetable and fruits	10.86	9.92	9.94	10.08	10.19	10.34

Table 9. Gains from Water Reallocation by a Water User-Right Market

	Year 1	Year 5	Year 10	Steady State
Water shadow price without water user-rights market, % of the status quo				
Soft wheat	62.73	65.25	74.64	77.77
Hard wheat	98.42	101.40	106.44	111.45
Other cereals	109.82	110.95	115.79	123.33
Industrial crops	105.79	106.38	106.46	108.00
Vegetable and fruits	120.89	120.34	122.95	125.02
Water shadow price with water user-rights market, % of the status quo				
	111.24	111.58	114.93	118.26
Sectoral demand for water after water user-rights traded, % of the status quo				
Soft wheat	60.79	62.16	67.73	68.49
Hard wheat	89.56	91.77	93.34	94.81
Other cereals	99.21	99.78	100.82	103.36
Industrial crops	93.64	94.09	90.66	89.57
Vegetable and fruits	109.74	108.84	107.88	106.42
Direct gains from water user-rights market, % of the status quo				
Soft wheat	19.02	17.53	13.00	12.75
Hard wheat	1.34	0.84	0.57	0.35
Other cereals	0.01	0.00	0.01	0.17
Industrial crops	0.35	0.31	0.79	1.07
Vegetable and fruits	0.94	0.77	0.63	0.43

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