ECOLOGICAL ECONOMICS

Ecological Economics 41 (2002) 125–144

This article is also available online at:
www.elsevier.com/locate/ecolecon

ANALYSIS

Market-based conservation and local benefits: the case of argan oil in Morocco

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Received 22 October 2001; received in revised form 31 January 2002; accepted 31 January 2002

Abstract

Market-based approaches to biodiversity conservation gained popularity in the 1990s. The success of these strategies hinges on, first, the successful creation or expansion of target markets and, second, the beneficial involvement of local stakeholders in these markets so that improved incentives induce conservation. This paper evaluates these two key elements in the case of argan oil commercialization in southwestern Morocco. The principal finding is that even when locals appear well-positioned to reap ex post benefits, one can reject the hypothesis that successful resource commercialization necessarily stimulates local development and reduces poverty. Most locals participate only superficially in the new and expanded markets for argan oil, and the benefits that do trickle down to local households appear to be regressively distributed, both regionally and between households. The key lies in understanding how opening or expanding markets may induce endogenous product differentiation that easily excludes locals, especially the poor, and how ex ante market access—a variable commonly correlated with wealth—conditions households' capacity to participate in market-induced producer windfalls. © 2002 Elsevier Science B.V. All rights reserved.

Keywords: Resource commercialization; Conservation; Economic development; Bioprospecting

1. Introduction

Market-based conservation approaches, including bioprospecting, ecotourism, game cropping, non-timber forest product marketing, and niche commodity (e.g. shade-grown coffee and organic foods) commercialization, have gained significant popularity over the past decade. These conservation strategies presume that because the target natural resource is insufficiently valuable for locals to protect, one must seek to create novel or expanded markets in order to increase locals' valuation of biological resources so as to induce conservation. Thus, improving local incentives to protect or conserve biodiversity hinges on locals benefiting from newly created resource markets. Although such efforts appear to work well in some settings, a sufficient mass of empirical evidence does not yet exist to conclude that these approaches benefit locals substantially enough to

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PII: S0921-8009(02)00020-4

induce conservation. This paper contributes to the literature on market-based conservation approaches by exploring whether locals benefit from market-based conservation.

We present evidence on how locals are benefiting from the successful commercialization of argan oil in southwestern Morocco. The argan oil case is largely a bioprospecting story. European chemists recently discovered that the oil from the nut of the argan tree endemic to the dry forests of southwest Morocco exhibits desirable biochemical properties for cosmetics sold commercially throughout Europe, Israel and around the world. Argan oil was thus successfully bioprospected in a manner that strongly resembles the indigenous knowledge-driven bioprospecting approach championed by Shaman Pharmaceutical.[1] The argan case is also partly a story of non-timber forest product marketing and niche commodity commercialization since argan oil commercialization requires ongoing nut harvesting. Attempted introductions elsewhere have achieved little success and synthetic substitutes have yet to be developed. The extraction of oil from argan nuts occurs ex situ since the low value to weight ratio makes exporting the nuts for extraction ex situ unprofitable.

Our principal finding is that even when locals appear well-positioned to reap the ex post benefits of successful resource commercialization, one can reject the hypothesis that it necessarily fuels local development and reduces poverty. Because of the natural restrictions on market access due to infrastructure (especially roads and electricity) and financing limitations, most locals participate only superficially in the newly created or expanded markets, and the benefits that do trickle down to local households appear to be regressively distributed, both regionally and among households. The key lies in understanding how opening up new markets may induce endogenous product differentiation that easily excludes locals, especially the poor, and how ex ante market access—a variable commonly directly related to wealth—conditions households' capacity to participate in market-induced producer windfalls. In the final section, we discuss the resource implications of this regressive distribution of benefits and situate these case-specific conclusions in a broader family of related literature.

2. The welfare effects of market-mediated shocks

At first glance, the link between successful resource commercialization and local economic development appears conceptually simple. Successfully establishing new or expanded markets for biota should increase the price of the resource and its products, thereby increasing the welfare of those with usufruct rights to the newly valuable resource. There are, however, several implicit and debatable assumptions in this simplified logic. In this section, we present a general conceptual model to establish who benefits from such market-mediated shocks.

Two dimensions of successful resource commercialization especially affect the resulting local development consequences. First is the value of the biological material genuinely discovered (i.e. previously unknown), or simply validated or learned by outsiders (i.e. previously known and used locally). This tends to dictate the existence and strength of local property rights over the source biota. These rights of control or ownership directly influence how and which locals benefit. In light of pervasive asymmetries in power and influence, locals may have little control over the exploitation of genuinely discovered material and may not benefit substantively in such cases. When locals already control and exploit a resource, they should benefit more, ceteris paribus. Second, the degree and nature of local involvement in commercialization have direct bearing on local gains. When extraction and commercialization occur in situ and 'bioprospectors' can entirely exclude lo-

[1] Shaman Pharmaceutical Inc. was established in 1990 with the goal of using indigenous knowledge-driven bioprospecting as a means to simultaneously develop drugs, add value to biodiversity and build up communities near the resource (see Bierer et al., 1997). The approach was hailed by many as a means of ensuring local peoples benefit. In 1998, however, in response to poor profit performance, Shaman shifted their focus from pharmaceuticals to botanicals (see www.shamanbotanicals.com). The argan oil story especially closely resembles the thrust of Shaman Botanicals.

cals from a success (i.e. biopiracy), potential local benefits disintegrate. Conversely, in situ, ongoing extraction and commercialization ought to maximize the likelihood of broad-based sharing of the resulting gains (Barrett and Lybbert, 2000).

Given these two dimensions, one might hypothesize that the best-case scenario from locals' perspective would involve a commercialization success in which (1) local control over the resource is well established (e.g. due to prior local use) and (2) extraction and commercialization are in situ and ongoing. As we describe in the next section, the argan oil case fits both of these characteristics, and thus provides a best-case scenario of the local welfare effects of successful resource commercialization. Given this favorable scenario, the fact that we fail to find significant local economic benefits, especially among the poor, calls into question the purported economic development and poverty alleviation claims often associated with market-mediated conservation (see Eisner, 1989; PAHO, 1996; Reid et al., 1993; Weiss and Eisner, 1998).

Market-based conservation approaches aim to create novel or expanded outlets for previously unexploited or underexploited biota. The expectation is that once desirable properties of tropical biota are discovered—or indigenous knowledge is corroborated by western scientific methods, as was the case with argan oil—then the price of the product increases, benefiting producers and, through the capitalized value of the flow from the source biota, resource owners. So the key issue is the distribution of the welfare effects of induced price changes. As Deaton (1997) shows, the instantaneous price elasticity of money metric welfare—i.e. the welfare shock due to a change in the price of product i prior to quantity adjustments and general equilibrium effects—exactly equals the net benefit ratio, $\beta_i \equiv p_i m_i / Y$, where p is the price of the product, m is a household's net marketable surplus, equal to production less consumption, and Y is household income. Barrett and Dorosh (1996) show that an analogous measure, $\beta_i^s \equiv p_i s_i / Y$, captures the instantaneous income effects—i.e. excluding transfers and capital gains on savings in kind—where s is the household's net sales of the product in question. As is well known, net buyers lose and net sellers gain from a price shock. In a slightly more general fashion, allowing for a vector of products related to the market shock in question—some of which may emerge endogenously as a result of the shock—the instantaneous income and welfare effects of a market-mediated shock to the price vector $\boldsymbol{P}$ are $\beta \equiv \Sigma_i \Delta p_i \beta_i$ and $\beta^s \equiv \Sigma_i \Delta p_i \beta_i^s$, respectively. Longer-term welfare and income effects also then turn on (i) households' quantity responses to price shocks (the full partial equilibrium effect), and (ii) general equilibrium effects on local wages and the prices of other locally non-tradable factors and products.

So in order to understand the welfare effects of successful resource commercialization, one needs to know (i) how prices change for various products related to the biota in question, (ii) the marketable surplus or net sales positions of households, (iii) what sorts of partial equilibrium changes occur in quantity of product produced (e.g. harvest volumes of tree products) or consumed, and (iv) what, if any, general equilibrium effects occur and who is likely to benefit or lose from these. After introducing the setting of Morocco's southwestern argan forests and the data in the next section, the remainder of this paper explores these four issues, paying special attention to the first two issues, which seem most important in the case of argan oil.

3. Background, data, and wealth distributions

The argan tree (*Argania spinosa* (L) Skeels) is endemic to Morocco, where it covers 867 000 ha, second in coverage only to the cork oak tree. The argan tree is unique and ecologically valuable; it is the only species of the tropical family Sapotaceae that remains in the subtropical zone, and its deep roots are the most important stabilizing element in the arid ecosystem, providing the final barrier against the encroaching deserts (Morton and Voss, 1987; Mellado, 1989; M'Hirit et al., 1998). In recognition this unique ecosystem, UNESCO recently declared the argan forest region a Biosphere site. The argan forest lies primarily within the provinces of Agadir, Taroudant, Tiznit, and Essaouira, hereafter termed the Argan Forest Region (AFR).

The argan forests are indispensable to the Berber peoples of the AFR, who have relied for centuries on the peculiar argan tree (Aouad, 1989). Specifically, the argan tree provides the local people with firewood and charcoal for heating and cooking; wood for carpentry and construction; fodder for their animals; shade and soil stability for their crops; and oil for culinary, cosmetic and medicinal purposes. As a result of these services, it is estimated that 90% of the rural economy in the AFR depends on argan-based agroforestry systems (Benchekroun, 1990).

The importance of the argan tree in Berber society is reflected in the clearly established rights that dictate both spatial and temporal use of the forest. Each village is allocated a forest tract, which the village divides into a quasi-private portion (agdal) and a communal portion (azroug). Both portions of the tract are used communally by the villagers from September until May. During the fruit harvest season (May–September), however, households exercise exclusive usufruct harvest rights to a particular section of the agdal portion. While these usufruct rights, called agdal rights, are marketable, locals transfer these rights mostly through inheritance.[2] Villagers communally exploit the azroug portion year round (for more on the curious tenure system of the argan forest and conservation implications see Lybbert et al., 2001; De Ponteves et al., 1990).

The data used in this paper were collected via a household (HH) survey using a stratified cluster sampling strategy in the Smimou Caidat, a county-like administrative unit located in the Essaouira Province in southwest Morocco. Villages in the Smimou Caidat were stratified by forest density (low, average and high).[3] We randomly selected two villages in each density class. With the help of village officials, we sorted HHs within selected villages into two categories, those with few or many agdal rights, and then randomly selected HHs from each category. The survey was fielded separately with the male and female heads of HH. We surveyed approximately 20 HHs in each of these villages, yielding a total sample size of 117.

Table 1 displays descriptive statistics of the data. Average and maximum HH land holdings[4] are highest in low density forest, which is unsurprising since forest land is communally, not privately, owned. Table 1 also presents statistics on the total number of argan trees to which the HH has access[5] and the subtotal that grow on the HH's private land. For the full sample, the average number of total and private[6] argan trees held by the surveyed HHs is 345 and 59, respectively, indicating that on average 83% of the forest is exploited via agdal rights to communal forest. While the mean number of total argan trees held by HHs in high density forest is predictably greater than the mean in mid and low density forest, the mean number of private trees is higher in low density than in the other classes.[7] Considering the mean land holdings and mean 'private' argan trees in tandem, it appears that the mean density of argan trees on private land is higher in low density than either high or mid-density forest. This seemingly paradoxical finding may be due to

[2] It is, therefore, extremely rare that non-residents possess usufruct rights to the argan forest.

[3] To sort villages in the Smimou Caidat into low, average and high argan forest density, we consulted local and regional forestry officials in conjunction with topographical maps and a 1996 forest inventory. Sampling proportions across villages ranged from 23 to 34% and have been corrected for in all aggregate statistics reported here. In calculating means, standard deviations and Gini coefficients, we use sampling weights, calculated based on a two-stage stratified design to ensure reliable inference with respect to the broader population (Deaton, 1997).

[4] Land is measured in khadams (KH), a local land unit measuring approximately 32 m^2.

[5] This includes both trees on the HH's private land and trees in the HH's agdal(s), to which the HH has usufruct access rights according to the customary tenurial arrangements of the AFR.

[6] All trees are 'owned' by the state and thus are not technically 'private'. Nonetheless, to simplify the presentation 'private' argan trees will refer henceforth to those trees that grow on privately owned land.

[7] This discrepancy is likely due to larger land holdings in low density forest. Also, it seems that low density areas have tended towards quasi-enclosure or privatization of argan trees where high density areas remain more dependent on customary communal tenure regimes.

Table 1
Household productive assets

		Full sample	Breakdown by density categories		
			High	Mid	Low
Land (KH ≈ 32 m^2)	N	115	42	37	36
	Mean	23	18	20	27
	Median	12	12	11	15
	S.D.	46	15	26	62
	Maximum	400	50	120	400
	Gini	0.56	0.38	0.53	0.62
Total number of argan trees (private and agdal)	*N*	114	42	37	35
	Mean	345	687[a]	299	315
	Median	60	200	50	60
	S.D.	772	953	870	589
	Maximum	5000	5000	5000	2000
	Gini	0.68	0.65	0.84	0.79
Number of argan trees on private land	*N*	115	42	37	36
	Mean	59	55	31	86
	Median	10	10	5	10
	S.D.	235	198	87	320
	Maximum	2000	1600	500	2000
	Gini	0.86	0.82	0.84	0.87
Average expenditure at Souk	*N*	116	43	36	37
	Mean	152	163	112[a]	186
	Median	150	150	100	200
	S.D.	96	88	41	117
	Maximum	600	500	250	600
	Gini	0.27	0.24	0.20	0.25
Average monthly household income	*N*	86	30	27	29
	Mean	1020	742	818	1264[a]
	Median	750	600	750	1000
	S.D.	787	581	606	892
	Maximum	3000	2500	3000	3000
	Gini	0.49	0.50	0.40	0.39

[a] Indicates significant difference relative to other category means (10% level).

low density HHs using their private land less intensively relative to their high and mid-density counterparts. Low density HHs also have fewer argan trees near their village that they can exploit and may, therefore, have a greater incentive than high and mid-density HHs to protect the argan trees growing on their private land. Consistent with the evidence on asset holdings, HHs in low density regions typically spend and earn the most, followed by HHs in high density. Mid-density HHs spend significantly less at weekly markets on average than high and low density HHs.

We use the data summarized in Table 1 to construct a HH wealth index. This scalar measure of HH wealth is key to our analysis of who benefits from argan oil commercialization. In order to construct a HH wealth index, one must devise a set of weights associated with each element of a HH's asset/expenditure vector. Rather than imposing arbitrary weights, we use factor analysis to allow the data to determine them directly.[8] Since HHs in each density class may hold wealth in different assets due to density-spe-

[8] Sahn et al. (1999) and Lawley and Maxwell (1971) discuss the technicalities of constructing wealth indices by factor analysis and compare factor analysis to the principal components method.

Table 2
Factor analysis results

Tested hypothesis	DF	Chi square	P-value
H_o: no common factors	21	126.513	<0.0001
H_A: at least one common factor			
H_o: one factor is sufficient	14	20.228	0.123
H_A: more factors are needed			
Elements of $\boldsymbol{w}$			Standard scoring coefficients
Education dummy			0.010
Remittances dummy			0.089
Log (goat herd)			0.102
Log (land)			0.243
Log (total argan)			0.308
Log (private argan)			0.421
Log (goat meat expenditure)			0.043

cific natural or man-made features and may exhibit distinct expenditure patterns due to differential market access, it may be problematic to assume ex ante that there exists a single common factor; W_i, valid across all regions. The remedy for this complication is to let the data determine how many common factors are responsible for the variation in wealth.[9]

The results of the factor analysis are shown in Table 2. There indeed exists a single common factor. The resulting vector of standardized scoring coefficients suggests that the most prominent component of wealth is the number of argan trees controlled by the HH.[10] This very directly addresses the question of access to argan fruit. Put simply, wealth and access to fruit are strongly positively correlated since usufruct rights in argan trees are the primary determinant of wealth.

Fig. 1 displays the cumulative wealth factor distributions for each density category. The low density region's wealth distribution stochastically dominates that of the mid-density region in the first degree. While the high density region enjoys higher mean wealth, its wealth distribution does not stochastically dominate the mid-density region's. As argan tree holdings weigh prominently into the calculation of the wealth factor, low density HHs do not dominate high density HHs. It does appear, however, that low density areas have fewer poor (<0) and more rich (>1.5) households relative to high density areas. So the wealth rankings are entirely consistent with the raw expenditure and income data.

4. Marketing channel effects, product differentiation and technological change

Traditional argan oil extraction is quite labor intensive, beginning with fruit collection, generally occurring between mid-May and mid-September when the fruit ripens.[11] As argan branches are studded with long thorns and plucking the fruit directly from the tree is difficult, the women and children who collect the fruit have three harvesting options. First, they can wait until the fruit is sufficiently ripe that it falls to the ground where it

[9] This is done by incrementally increasing the number of common factors (n) used in the factor analysis and statistically testing the null hypothesis that n common factors sufficiently explain the variance–covariance matrix of $\boldsymbol{w}$, the vector of assets used to calculate the measure of wealth.

[10] The argan trees controlled by the HH are broken down into 'private', which includes only trees on the HH's private land, and 'total', which is the sum of the HH's private trees and the trees controlled by agdal rights.

[11] When ripe, argan fruit are generally larger than an olive, but smaller than a chicken egg.

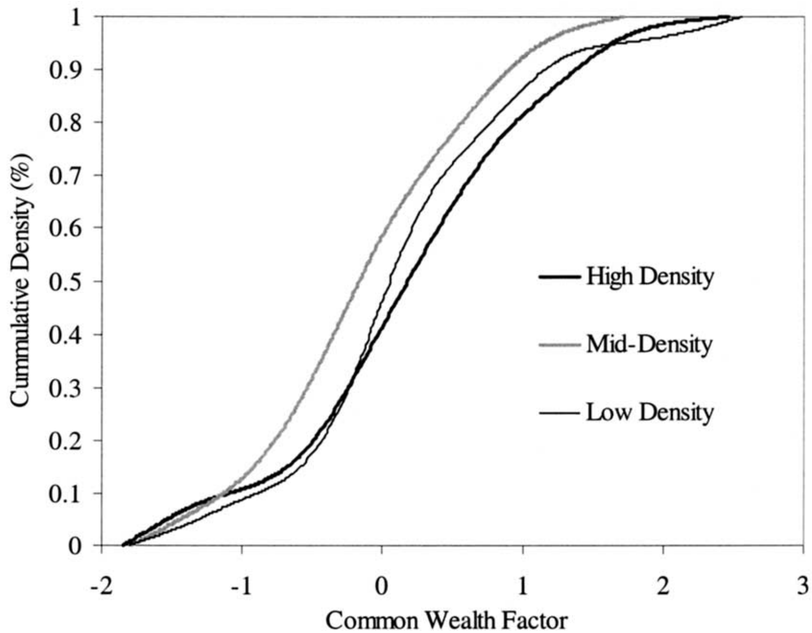

Fig. 1. Cumulative distribution for the common wealth factor by density class.

can be collected easily. Second, a fruit collector can help the fruit fall with a stick or by throwing rocks. In either case, once the fruit is properly dried, women use wedge-shaped rocks to strip the pulp off the argan stone, which is light brown, smooth, and about the size and nearly the hardness of a marble. The leathery pulp is fed to livestock. Third, if allowed, goats will climb nimbly into the canopy of the tree and will eat the fruit directly. The collectors later sort through the goat manure to find argan stones, already stripped of the pulp by the goat's digestive tract.

Next, the argan stones must be cracked open to get the oil rich nut. Traditionally, women crack the stones using rocks and use the shards of shell as a hot-burning combustible. Extracted nuts, after being roasted, are crushed into an oily paste, which is laboriously kneaded to coax the oil from the paste.[12] The oil is collected, generally in reused plastic bottles, to be consumed by the family or sold at market in the local village by the male head of household. While informal, local markets for argan fruit, stones, pulp and the residual argan oil paste seem to have existed historically, the market for argan oil has always been better developed.[13] Still, only a small fraction of total oil production was marketed traditionally.

While domestic argan oil markets (both urban and rural) had grown steadily through the mid-1990s, much of this growth was due to scale expansion, with little or no apparent pressure on the nature of traditional argan oil extraction, marketing and product differentiation. In contrast, a dramatic commercialization expansion occurred in the mid- to late 1990s due to successful indigenous knowledge-driven bioprospecting. This caused a fundamental shift in the nature of the demand for argan products. Validation of traditional claims of argan oil's virtuous biochemical properties as a moisturizer, and for acne and

[12] Once all the oil that can reasonably be pressed out of the paste by hand is extracted, the clay-like residue is shaped into small patties for use or sale as a rich livestock feed.

[13] Historical accounts indicate argan oil was marketed in local markets and even exported for a time to Europe (Morton and Voss, 1987), most notably to France, where soap was occasionally produced from the oil in the 1790s (Koubby and El Jarjaf, 1997).

wrinkle reduction by European and other Western-trained chemists, sparked rapid growth in demand for argan oil in non-traditional urban and export markets, and derivatively, evolution in the extraction and marketing processes for argan fruit and oil. In what follows, we refer to the market of these two periods as the pre- and post-bioprospecting markets, respectively.

With the discovery of the biochemical virtues of argan oil, mechanization has entered the process in two ways. First, mechanical presses are gradually replacing the tedious manual pressing techniques. These mechanical presses not only increase the total oil yield by nearly 50%, they also allow the producer more control over the extraction process so as to render a purer, higher quality oil. So far mechanical presses and testing instruments have been introduced into argan oil processing only on a very limited scale.[14] Second, mechanized testing equipment is now used to guard against impurities due to collecting argan stones 'by goat', oil dilution, unhygienic processing and other ambient impurities. These quality controls have become a prerequisite for marketing higher-value argan oil to non-traditional urban and overseas (especially European and Israeli) consumers. Both types of mechanization have had significant upstream and downstream repercussions on the extraction process and on primary and secondary product markets.

Information concerning factor and product quality has always played a significant role in argan oil pricing. In the pre-bioprospecting market, a traditional producer had three marketing options. First, he could sell his artisinal oil directly at market to reasonably anonymous buyers. Second, he could dilute his argan oil with a cheaper, relatively neutral oil like ordinary vegetable oil and likewise sell it at market to anonymous buyers. Due to the strong smell and flavor of argan oil, this deception is easy to pull off and has long been common. The third marketing option was to sell argan oil through one's social networks. This third option entails greater effort (and, therefore, cost) than simply going to market, which men do whether or not they market oil. If the producer leveraged his reputation to convince familiar buyers of the purity of his oil, he could earn a premium over the market price. The argan oil market was thus a classic case in which clear and credible signals by sellers to buyers resolved product quality information asymmetries, generating a separating equilibrium of low and high quality products. In the absence of such signals, however, consumers could not distinguish product by quality and thus all goods were priced identically, resulting in a pooling equilibrium in which sellers' optimal response was to offer low quality (Akerlof, 1970).

In the spot market, the absence of credible quality signals drove the price of diluted oil (regardless of whether the source nuts were goat-ingested ($P_o^{-g\prime}$)[15] or not ($P_o^{-\prime}$)) to that of undiluted oil (P'_o or $P_o^{g\prime}$, again regardless of whether the source nuts were goat-ingested).

$$P'_o = P_o^{-\prime} = P_o^{g\prime} = P_o^{-g\prime}$$

For simplicity, call this pooled price $P_o^{-*\prime}$. Reputation marketing allowed sellers to overcome the market failure caused by asymmetric information regarding oil quality. If the seller successfully convinced the buyer, the buyer would willingly pay $P_o^{+*\prime}$ ($P_o^{-*\prime}$ plus a premium).[16] An argan oil producer, therefore, marketed his oil via social networks only so long as the premium associated with reputation marketing, $(P_o^{+*\prime} - P_o^{-*\prime})$, at least equaled the implicit cost of establishing, maintaining and tapping social networks.

[14] As of 1999, there were six mechanical presses known to be in operation in the AFR. There are almost certainly machines in operation in Europe as well, since the cosmetic companies that are producing moisturizers with an argan oil base must procure the oil, and there is no evidence that they are purchasing the oil from press operators located in Morocco.

[15] To clarify notation, substripts designate the form of the product (o for oil, f for fruit), superscripts quality (− for diluted, g for goat impurities), and the prime (′) indicates the pre-bioprospecting market (e.g., P'_f is the price of a single argan fruit in the pre-bioprostecting market, and P_f is the price of a single argan fruit in the post-bioprospecting market).

[16] As in the $P_o^{-*\prime}$ case, $P_o^{+*\prime} = P_o^{+\prime} = P_o^{+g\prime}$ because goat-impurities are unimportant or at least undetectable in pre-bioprospecting markets.

Fig. 2 maps the marginal cost curves of two stylized producers: AOP_1 and AOP_2. The horizontal axis reflects oil quality (i.e. the degree of oil dilution in the pre-bioprospecting market). The vertical axis reflects cost and price in a competitive market in Moroccan Dirhams (DH) per liter. This marginal cost curve is largely a function of the perceived cost of establishing and maintaining both a network of acquaintances and a sufficiently good reputation. AOP_1 has a cost structure such that the marginal cost of reaping the premium is greater than the undiluted oil premium associated with this extra effort. AOP_1, therefore, opts to forego reputation marketing and to sell oil at market where the price pre-bioprospecting was approximately 35 DH/l (El Otmani, 1986; De Ponteves, 1989; Aouad, 1989; Charrouf, 1995).[17] For AOP_2, on the other hand, it pays to sell pure oil via social networks and to reap a premium of approximately 10 DH/l. The pre-bioprospecting market for argan oil thus had a two-tiered equilibrium price schedule. Producers essentially selected the price they received according to their marginal cost structures.[18]

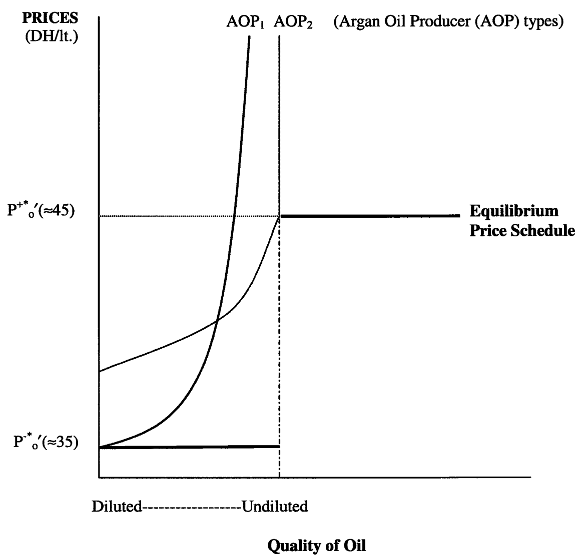

Fig. 2. Producers' marginal cost and equilibria in the pre-bioprospecting market.

Bioprospecting-induced commercialization affected market equilibria by introducing argan oil into new, distant markets requiring product quality signaling by means other than reputation marketing. By necessity, extensive argan oil commercialization and the adoption of new market signaling techniques proceeded simultaneously due to the (assumed) more discriminating tastes of high-income consumers. Both had implications for argan market equilibria, resulting in three new separating equilibria.

In the first equilibria, commercial producers improved the hygiene of the extraction process, introduced testing to ensure a higher grade of oil and began using guarantees, improved packaging and labeling. As a result, some producers have been able to fetch a higher price (P_o^{++}).

Discriminating high-income consumers have proved willing to pay for oil quality improvements due to better hygiene and to screening for 'goat impurities,' making this quality improvement profitable for some producers.[19]

In the second equilibria, new entrants practicing mechanical extraction are able, like the previous producers, to improve the hygiene of the extraction process and to test for the oil quality. But because mechanically-extracted oil is slightly purer and hence has a longer shelf life, mechanical producers market their oil as 'mechanically-extracted' and receive $P_o^m > P_o^{++}$ because consumers in high-value markets will pay for such improvements.

The third equilibria involves cosmetic oil, which mechanical processors can produce by extracting

[17] Prices of argan products (i.e. fruit and oil) vary with forest productivity and, hence, weather. Thus, the prices in the following discussion represent averages.

[18] Producers' marginal cost schedule may change over time or once volume sold hits a certain level. For example, when he exhausts his network of acquaintances, the cost of further reputation marketing may jump significantly, causing him to sell any remaining oil at market. The equilibrium price levels are likewise subject to fluctuations as annual changes in market prices present different payoffs to reputation marketing.

[19] We assume that the income elasticity of demand for quality improvements is greater than one, so that although traditional argan oil consumers in the AFR may care about quality, they are less willing to pay for quality improvements than are higher income consumers.

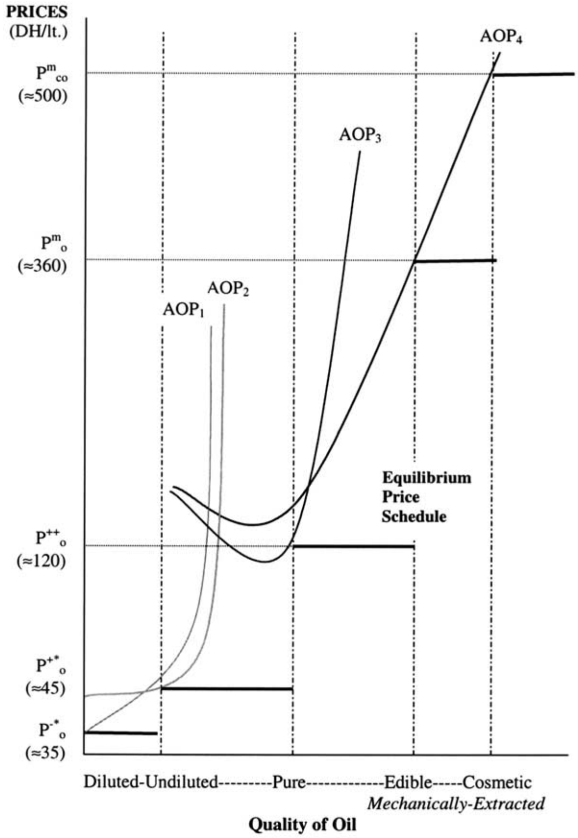

Fig. 3. Producers' marginal cost and equilibria in post-bioprospecting argan markets.

oil from unroasted nuts.[20] Cosmetic oil fetches a still higher price, $P^{\mathrm{m}}_{\mathrm{co}} > P^{\mathrm{m}}_{\mathrm{o}}$, because obvious visual differences in oil send clear signals of purity to consumers.[21]

Fig. 3 graphically illustrates these new processing and marketing strategies, and associated marginal cost curves and prices, in the post-bioprospecting argan oil market. As in Fig. 2, AOP_1 and AOP_2 in Fig. 3 represent the marginal cost curves of the diluted oil producer and reputation-marketed oil producer, respectively. Even though the post-bioprospecting market differs dramatically from the pre-bioprospecting market, the average nominal prices received by AOP_1 and AOP_2 (ca. 35 and 45 DH, respectively) have remained similar in both cases (in real terms, these prices probably fell).[22] Thus, the shape of the marginal cost curves of these two producers is instructive. Due to the lumpiness of the investment required to obtain the next quality threshold, a single traditional producer cannot make such an investment and the shadow cost of capital is infinite for AOP_1 and AOP_2.

The newly introduced argan producers, AOP_3 and AOP_4, represent stylized entrants who capitalize on emerging markets for higher quality products. Since they are trying to reach larger, distant markets, reputation marketing based on social networks does not suffice. They need methods that can assure anonymous buyers of oil quality. AOP_3 represents the producer who extracts the oil artisinally, then tests for oil purity (i.e. absence of 'goat impurities') and markets the oil with packaging, labeling or guarantees that assure potential buyers of oil purity. This new process results in a higher quality threshold and a higher price P^{++}_{o}, but it requires lumpy investment in mechanical testing equipment and improved packaging and labeling.[23] In order to make and justify such an investment, a producer must have access to sufficient capital and must produce and market on a much larger scale than is common among traditional, artisinal producers. For individual traditional producers, these prove to be almost insurmountable prerequisites. There have been, however, a couple of reasonably successful efforts at forming cooperatives to surmount the problems of capital access and marketing scale.

[20] Due to hygiene, filtering and other constraints, high-value cosmetic oil cannot be extracted by artisinal producers.

[21] Oil destined for cosmetic use must also be filtered since unfiltered oil has a milky appearance and texture. Several cosmetic firms use cosmetic argan oil as an intermediate input to the production of moisturizers and lotions. Several such products are being marketed, both by large cosmetic companies such as Yves Rocher and Colgate–Palmolive, and by small specialty firms.

[22] Since historical argan price data are non-existent, this is a rough comparison based on extensive key informant interviews.

[23] Investment in the proper testing equipment represents a fixed cost of approximately $2000 and requires some variable costs to operate (e.g. maintenance and electricity). Improved packaging and labeling costs roughly $800 per 10 000 l.

AOP_4 is a producer who tests for oil purity and markets the oil the same way AOP_3 does. AOP_4 opts, however, to extract the oil from the nuts mechanically.[24] This requires the same testing and marketing investment as before, plus an investment of around $12 000 (1999) in a mechanical press. Mechanical presses allow the producer to extract both edible and cosmetic oil. Mechanically extracted edible oil fetches roughly three times the price of artisinally extracted, tested oil, and cosmetic oil earns better than four times as much. Since cosmetic oil requires expensive filtration equipment in order to generate clear oil, cosmetic oil costs somewhat more to produce than does edible oil. Still the marginal revenue associated with producing and marketing cosmetic oil is sufficiently great relative to its marginal cost that mechanized producers with access to electricity and the proper marketing channels are principally concerned with cosmetic oil.

The sunk cost of acquiring machinery and locals' limited liquidity and access to electricity preclude traditional producers from entering the higher-return niches of the argan oil market (with the exception of a few participants in cooperatives). So in actuality the producers represented by AOP_3 and AOP_4 in Fig. 3 have proved to be non-local, wealthier entrants into the argan oil market. The demand for the high quality argan oil they produce has expanded rapidly in recent years. Upscale restaurants in New York, London and Paris feature the nutty oil (e.g. warmed and drizzled over goat cheese) (Fabricant, 2001). Specialty shops and internet vendors have sprung up, selling the oil for upwards of $200/l with claims that it is the world's rarest and most expensive edible oil (e.g. www.exoticaoils.com, www.arganoil.com, www.gourmetoil.com).

Traditional argan oil producers of the AFR have access only to the lowest price equilibria in the post-bioprospecting argan oil market, the same equilibria as existed for them prior to bioprospecting-induced commercialization. The direct benefits of expanded commercialization seems to have accrued primarily to outsiders, not to AFR residents, as was widely hoped. Since the AFR is one of Morocco's poorest regions, the endogenous market changes associated with serving a new, higher-end market have severely tempered the purported poverty alleviation benefits of successful resource commercialization in Morocco.

Proponents of market-based conservation strategies observe or hypothesize about substantial premia earned in non-traditional markets, like those reflected in Fig. 3, and then leap to the conclusion that locals' valuation of the underlying resource must be increasing (Eisner, 1989; PAHO, 1996; Reid et al., 1993; Weiss and Eisner, 1998). It, therefore, follows that the traditional producers who control the source biota—in this case, the argan trees—face greater conservation incentives. This overlooks the critical issue of mobility barriers that bar entry into more profitable marketing niches, a problem that pervades low-income markets (Fafchamps, 1994; Barrett, 1997). For low-income, liquidity- and infrastructure-constrained AFR residents, the capital investments necessary to improve argan oil quality and reap the associated market premia are infeasible. For non-traditional producers who can make the requisite lumpy investments, however, the return to meeting these new quality thresholds is potentially quite handsome. So much of the direct gains accrue to new, wealthier entrants from urban markets.

Although they are the main direct beneficiaries of the emergence of non-traditional markets for high quality argan oil, the wealthier, non-local owners of partially or fully mechanized operations typically do not have agdal rights to harvest sufficient fruit of their own. These producers must, therefore, buy most or all of the whole, dried fruit they need[25], either at rural markets or from argan

[24] The main reason why non-local producers such as AOP_3 do not adopt mechanized extraction and filtration methods relates to infrastructure constraints. Since most rural areas in the AFR do not have access to the electricity necessary to run mechanical presses, the marginal operating costs of the presses are essentially infinite. Producers like AOP_4 have access to electricity.

[25] Since high quality producers try to avoid goat-ingested stones, these mechanical extractors only purchase whole argan fruit, whose intact pulp ensures that the stones inside have not passed through a goat's digestive tract. Thus, only since the bioprospecting-induced changes to argan marketing and processing, a single whole fruit now earns a premium over the combined value of the detached pulp and the stone.

fruit middlemen, an entirely new class of argan market participants. The resulting expanded demand has driven up argan fruit prices throughout the AFR. In this way, the bioprospecting-induced demand shock has been propagated beyond just the owners of mechanized (or semi-mechanized) operations to those marketing argan fruit. In one site, Tidzi, mechanical extraction was introduced as part of an argan oil cooperative. The increased demand for argan fruit was strong enough relative to the size of the traditional local argan fruit markets that the price doubled almost overnight.

While data limitations make complete partial or general equilibrium analysis infeasible, we can nonetheless comment on likely induced changes. First, since nearly all the fruit in the forest was already collected, induced quantity responses due to higher fruit prices seem to have been minimal. Second, the arrival of mechanized operations in the AFR and the associated demand for local labor has not substantially affected wages. This is primarily because this nascent mechanization trend is relatively insignificant in the broader AFR economy. Further, these mechanized operations employ mainly female labor, which in the rural AFR has few other wage opportunities. Third, while the price of argan stones has fallen relative to that of whole argan fruit, the prices of argan fruit pulp, residual paste and shells have not changed appreciably as a result of mechanization. Mechanical extractors produce enormous quantities of these secondary products, but do not value these byproducts as highly as do local producers who use the pulp and residual paste as livestock feed and the shells as a combustible fuel. To date, however, mechanical operators sell most of their byproducts outside the AFR, thereby muffling any induced price effects in local markets.[26]

In summary, validation of indigenous knowledge surrounding argan oil sparked a sharp increase in high end demand for higher quality oil, leading to a significant increase in the price of non-traditional, high quality oil products and, derivatively, for argan fruit, but the price of traditional argan oil products and non-fruit unprocessed products such as stones and pulp did not increase and may have even fallen in real terms. With much of the gains from the boom accruing to outsiders who largely utilize mechanical processes, there has been no discernible effect on AFR labor markets, so wages have not changed in response to new, non-traditional commercialization of argan oil. In terms of the four key issues raised in Section 2, we now know that price changes dominate and that the general equilibrium effects induced by bioprospecting were modest to non-existent. Now we turn to explore the question of intra-regional and inter-household distributional benefits within the AFR.

5. Intra-regional and inter-household distribution of bioprospecting's benefits

Since AFR locals are likely to benefit primarily through increasing argan fruit prices, the analysis in this section focuses on how access to argan fruit and argan fruit markets varies across the AFR and among households. Argan fruit collection and oil extraction is ubiquitous in the Smimou Caidat. All of the HHs surveyed participate in either argan fruit collection or oil extraction. Most HHs do both. Access to fruit and markets, however, is far from homogeneous.

In the Smimou Caidat, forest density and population density are negatively correlated. Thus high forest density areas have the greatest per capita access to argan fruit, and may thereby seem to stand to benefit most from increasing fruit prices, while low forest density areas have the lowest per capita access to argan fruit, and thus may seem least well situated to benefit from the induced price shock. Table 1 suggests that

[26] Since pulp, residual paste and shells have a low price-to-weight ratio, and because they are typically produced in small quantities by many small producers, the market for these commodities has been restricted to the AFR. With the bulk production of these commodities by mechanical extractors, larger buyers outside the AFR are attracted to the pulp and shells market.

Table 3
Argan oil and fruit market transactions

		Full sample	Breakdown by density categories		
			High	Mid	Low
Argan oil (AO) sold previous week (l)	*N*	117	43	37	37
	Mean	0.21	0.48[a]	0.11	0.24
	Median	0	2	0	0
	S.D.	0.53	0.66	0.39	0.59
	Maximum	2	0	2	2
Argan fruit (AF) sold previous week (*abras* ≈ 14 kg)	*N*	117	43	37	37
	Mean	0.43	0.00	0.14	0.80
	Median	0	0	0	0
	S.D.	3.89	0.00	0.82	5.60
	Maximum	40	0	5	40
AO bought previous week (l)	*N*	117	43	37	37
	Mean	0.07	0.00	0.10	0.07
	Median	0	0	0	0
	S.D.	0.31	0.00	0.33	0.33
	Maximum	2	0	1.5	2
AF bought previous week (abras)	*N*	117	43	37	37
	Mean	0.02	0.00	0.00	0.04
	Median	0	0	0	0
	S.D.	0.19	0.00	0.00	0.28
	Maximum	2	0	0	2

[a] Indicates significant difference relative to other category means (10% level, df = 40).

low density HHs are on average wealthier than their mid- and high-density counterparts. If market access and participation were uniform across the AFR, increasing argan fruit prices could, therefore, yield progressive (i.e. pro-poor) regional income growth. There are, however, two complications. First, as seen in Table 2, agdal holdings are strongly correlated with HH wealth and quite unevenly distributed, as reflected in the high Gini coefficients, particularly for holdings on private land. Second, argan market access and participation in the AFR is far from uniform. As we will show, because of these two factors, it is wealthier HHs in low density areas that stand to benefit most from increasing fruit prices.

Table 3 presents summary statistics for household argan market transactions. Weekly quantities of oil marketed are small, averaging around 1/5 of a liter for the full sample. High density HHs market twice as much oil each week as do low density HHs and more than four times as much as mid-density HHs, both statistically significant differences. On the other hand, not a single high density HH reported selling any fruit at all, while mid- and especially low density HHs were more involved in the fruit market. Although the quantities sold are relatively small, they point to an important difference in market access between the density classes. High forest density villages are more distant from the fruit markets that have cropped up in more densely populated areas with necessary physical infrastructure (e.g. electricity, good roads) to support high quality, mechanized producers who lack direct access to fruit via usufruct rights. Argan fruit's low price-to-weight ratio makes transport to low density regions and cities unprofitable. So although high density HHs have greater access to argan fruit, they do not benefit from higher argan fruit prices because high marketing costs induce them to self-select out of argan fruit markets. The low density HHs exhibit the highest net fruit sales, although the differences between regional means are statistically insignificant because most households in

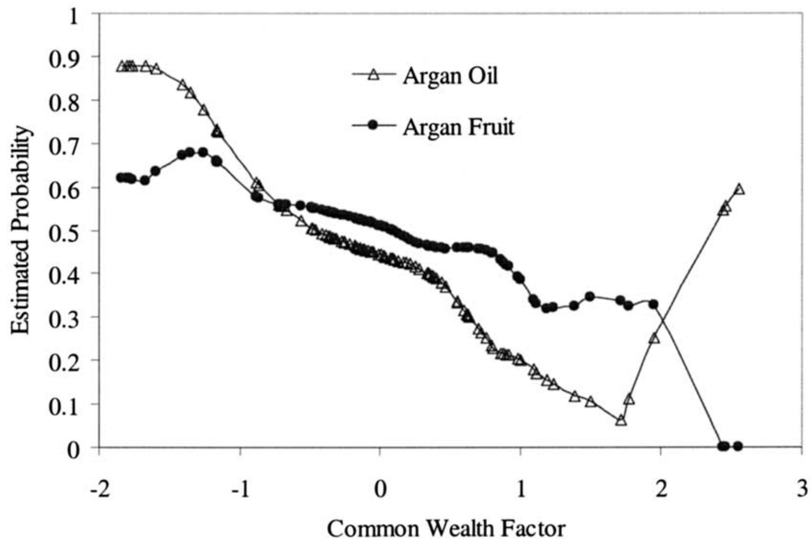

Fig. 4. HH wealth of argan product buyers.

each region do not sell fruit. Market access seems to trump tree access in establishing who benefits, leading to what appears to be a regressive distributional effect of argan fruit price increases within the AFR.

The likely inter-HH distributional effects can be established using the net benefit ratio or net sales ratio, β, for argan fruit. Due to data limitations, we approximate these measures by looking at HHs' discrete decision to participate or not to participate in argan markets as either sellers or buyers, conditional on household wealth using non-parametric regression techniques.[27]

HH wealth is strongly, positively correlated with the number of agdal rights held by the HH (Table 2), which largely determines the HH's access to argan fruit. Poor HHs with few agdal rights and little land endure meager fruit harvests from small degraded, unproductive tracts of the village forest allotment that remain communal during the fruit harvest season. Fig. 4 depicts the expected probability that a HH buys argan products given its wealth.[28] There is a very clear pattern in both regressions. Poor HHs are far more likely to buy argan products than are rich HHs. Among extremely rich HHs the probability of buying argan oil seems to rise precipitously, while that of purchasing argan fruit drops to zero (one must use caution, however, when interpreting such regressions at the tails of the conditioning distributions). This suggests that HHs buy argan oil either when they do not have sufficient resources (i.e. the poorest) or when argan production is insufficiently remunerative given their other options (i.e. the richest). So if commercializing argan oil increases the price of argan fruit and/or oil, the poorest HHs are most likely to be negatively impacted by cost of living effects.

Fig. 5 shows the expected probability that a HH sells argan products given its wealth. The probability that a HH sells argan oil in the market increases strongly with HH wealth as one moves from poverty to moderate wealth. Consistent with

[27] HHs rarely participate in argan markets as both a buyer and seller, so the indicator variable almost surely gets the sign of the welfare effect right even though it cannot capture the magnitude.

[28] These probabilities derive from the non-parametric regression, a dichotomous variable equaling zero for HHs that do not buy argan products from the market and one for HHs that do on the HH wealth index, using an Epanechnikov kernel with a global bandwidth of 1.0. The same method is then used for sales.

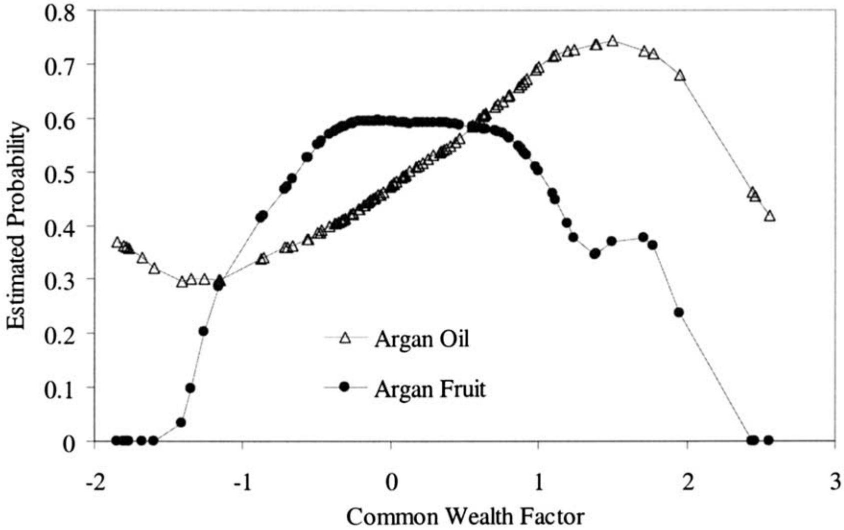

Fig. 5. HH wealth of argan product sellers.

the purchasing pattern, the wealthiest are, like the poorest, relatively unlikely to sell argan products. Argan sales seem to be the domain of the middle class, with the poor crowded out and the rich opting out. It seems that relatively poor HHs are not as likely as relatively wealthy HHs to sell argan oil, but are more likely instead to buy argan products. HHs of moderate wealth are least likely to purchase and most likely to sell argan products. These poor HHs may, therefore, benefit from the lower real price of traditional argan oil, but higher argan fruit prices clearly hurt poor HHs. In the absence of any discernible labor market effect, it, therefore, seems unlikely that there has been any appreciable benefit enjoyed by poorer subpopulations within the AFR.

It is clear that the barriers to entry into the emerging high quality argan oil markets are sufficiently high to exclude most, if not all, AFR locals from this market niche on their own. This has motivated the formation of two cooperatives in the AFR. The first is a non-mechanized cooperative sponsored by the GTZ. The second is a mechanized cooperative established by Zoubida Charrouf, a chemistry professor at Morocco's Mohammed V University, with the support of the European Union, Oxfam and the Japanese International Cooperative Agency, among others.

The GTZ cooperative organization consists of a network spread throughout the AFR. The pilot cooperative evaluated here was established in a small village, Ouchene, in high density forest near the Atlantic coast. In principle, any woman who resides in Ouchene may participate in the GTZ argan oil cooperative, provided she is willing to abide by the more stringent oil extraction-hygiene requirements set by GTZ and is able to meet production quotas when market demand is strong. As of 1999, there were 27 participants whom the GTZ paid 85 DH/l of pure, 'high quality' argan oil, which was tested, packaged and marketed as culinary oil in high-value domestic and international markets.[29] With a price so much higher than the price at market (35–45 DH/l), why do not the rest of the women participate? The answer apparently boils down to politics and ability to meet production quotas. Some men are hesitant to allow their wives to participate precisely because of the empowerment the cooperative is designed to promote.

The second cooperative combines mechanical analyses of oil purity with mechanical extraction

[29] The GTZ oil is sold in Morocco for 120 DH/l.

Table 4
Common wealth factor statistics for villages with cooperative (participant (part.) and non-participant (non-part.))

	Tidzi			Ouchene		
	All	Part.	Non-Part.	All	Part.	Non-Part.
Mean	−0.3695	−0.7221	−0.2129	−0.0009	0.1602	−0.2023
Median	−0.0529	−0.7804	−0.0190	0.0567	0.1404	−0.1789
S.D.	0.9456	0.9373	0.9602	0.9865	0.5344	1.4550
Minimum	−1.9677	−1.6196	−1.9677	−1.9919	−0.4375	−1.9919
Maximum	0.7616	0.2920	0.7616	1.5403	0.9930	1.5403

and has seen considerable success.[30] This cooperative operates in three locations in the AFR with plans to expand to two additional villages. In this paper, we analyze the cooperative located in Tidzi, a village in the low density forest. Participation in the Tidzi cooperative is selective and requires a membership fee of either 5 kg of argan nuts or 200 DH. There are currently 40 women participating in the Tidzi cooperative.[31] The women participate in the cooperative by peeling the pulp from the stones, cracking the stones, and removing the nut inside. Whole fruit is purchased by the cooperative and supplied to the women. Once extracted, the nuts are roasted (for edible oil) and fed into the mechanical press. The cooperative sells a variety of final products, including cosmetic oil (35 DH/60 ml), edible oil (120 DH/375 ml), and amalo (an almond–honey–butter with an argan oil base). Cooperative members are paid a piece rate of 25 DH/kg of nuts cracked. On average, a woman can extract between 0.8 and 1 kg in a single 8 h work day. This daily wage of approximately 20–25 DH/day is relatively low in comparison to the labor options that men face (35–40 DH/day), but it is very attractive to women since they have few or no wage labor work options.

Which HHs participate in these cooperatives? Table 4 displays some summary statistics for the common wealth factors of HHs in Ouchene and Tidzi. Tidzi HHs are generally poorer than Ouchene HHs. Furthermore, participants in the cooperative tend to be poor relative to non-participants in Tidzi, while cooperative participants appear to be better off than non-participants in Ouchene, although neither difference is statistically significant given dispersion and the small sample size. Moreover, it is unclear whether cooperative participants in Ouchene are relatively better off because of their participation or whether they participate because they are wealthy. Based on our casual observation, it is probably a combination of both. In the context of this paper's broader concern with the welfare effects of the argan boom, even though cooperative processing and marketing has the potential to give locals access to higher-margin argan oil production and distribution inaccessible to them as individuals, as may be happening in Ouchene, the distributional effects clearly depend on the cooperative's operating procedures. Despite potential organizational pitfalls, the success of the Tidzi cooperative provides hope for more meaningful local participation and conservation in the future.

Table 5 summarizes our findings. Recent argan oil commercialization has induced argan product differentiation that has probably caused the price of traditional argan oil to fall in real terms while the prices of new, high-value grades of argan oil have increased substantially. The latter effect has induced an increase in the price of argan fruit. Since capital and infrastructure necessary to produce and distribute high-value oil are largely un-

[30] This cooperative has had annual revenue of over $100 000 in recent years and has received numerous awards. Sixty percent of its sales are through its web site www.targanine.com, mostly to distributors in Europe and North America.

[31] Including temporary workers, who are needed to fill large orders by distributors, 250 women participate in the cooperative's three locations.

Table 5
Summary of induced welfare effects in Morocco's AFR

Households by		Apparent welfare effects due to		
Region	Wealth tercile	Higher real prices for high quality oil	Lower real prices for low quality oil	Higher real prices for fruit
Low density				
Forest	Poorest	0	+	−−
	Middle	0	−	++
	Wealthiest	0	+	−
Mid-density				
Forest	Poorest	0	+	0
	Middle	0	−	+
	Wealthiest	0	−	+
High density				
Forest	Poorest	0	0	0
	Middle	0	−	0
	Wealthiest	0	−	0
	Non-locals	++++	0	−−

+, indicates a positive welfare effect; −, a negative effect. The magnitude of the effect is increasing in the number of symbols shown. Non-locals enjoy highest mean income, followed by residents of low density forest, high density forest and mid-density forest, in that order. Other induced effects (e.g. on wages, on output volume, and on the prices of argan stones, pulp, shells, or residual paste) appear negligible.

available to them, AFR locals appear to benefit from the bioprospecting success almost exclusively as argan fruit sellers or as buyers of low quality oil. Middle class HHs and those in the richer, low density forest areas stand to gain most from emerging, lucrative argan fruit markets, while middle class and wealthier households in the poorest, moderate forest density region seem also to benefit a bit. Poor HHs are more likely to be buyers than sellers of argan products, and may, therefore, benefit slightly when they buy only low quality argan oil, as in the poorer cohort of the mid density region; but, much higher fruit prices probably more than offset modestly lower oil prices among the poor in the low forest density region. Although they control the most argan trees, residents of the high density forest region appear to benefit little from the argan boom because they sell neither high value oil nor fruit while they do sell low quality oil that has suffered real price reductions. Conversely, some cooperative arrangements appear to be successfully including AFR locals more directly in high-value argan markets. There remains, however, organizational challenges to establishing an efficient and equitable cooperative.

6. Discussion and conclusions

This paper explores the effects of a market-based conservation approach on locals' welfare. In the case of argan oil in Morocco, which on the surface seems a best-case scenario from the locals' perspective, changes induced in the production and distribution of argan oil effectively exclude most of the local poor from benefiting. Given the paucity of empirical evidence on the local effects of resource commercialization, the argan case is important and interesting for it suggests that distributionally regressive outcomes may result in settings where one would naturally hypothesize the poverty reduction effects of resource commercialization should be greatest.

Specifically, because product commercialization for new, high-end consumers induces the introduction of new processing methods and distribution channels, associated increases in raw or processed product prices do not necessarily benefit all HHs, much less equally. In the argan oil case, most of the gains appear to have accrued to non-locals able to overcome capital and infrastructural constraints to entry into the mechanized, high-end market, while the benefits to locals have been largely derivative, due to the higher prices mechanical processors pay for fruit. There is likely to be substantial inequality in the distribution of these latter benefits, both across regions according to market access and forest density and, among HHs based on rights in trees, and thus wealth. Due to their greater access to argan fruit markets, wealthier, low forest density region HHs market fruit more frequently than those of other density classes, illustrating that factors such as market infrastructure critically determine which villages benefit. Meanwhile, poorer households are more likely to purchase argan fruit, making them more likely to be hurt by increasing fruit prices.

To complete the analysis, it is necessary to relate these distributional consequences to conservation implications, which seem ambiguous in the case of the argan forest. Spontaneous reforestation by locals is unlikely to occur because the tree grows too slowly to make the required investments remunerative even after the price of argan fruit doubled. As a result of commercialization, however, locals are more apt to invest in enclosures to protect their mature trees, which presently produce the increasingly valuable fruit. Thus, in the short term the quasi-private agdal tracts of the forest stand to benefit from commercialization, while the communally exploited azroug tracts will be degraded further due to more concentrated exploitation. Locals who do benefit from commercialization will likely invest some of their increased wealth in livestock, which bodes poorly for the forest. More troubling still, locals have responded to increasing argan fruit prices with more complete and, at times, more aggressive harvesting techniques. Nearly all of the fruit produced by the forest is now collected, leaving little hope for natural forest regeneration. We discuss these resource implications in greater detail elsewhere (Lybbert, 2000; Lybbert et al., 2001).

The argan oil commercialization case described in this paper is broadly related to a wider literature on the distributional implications of policy or technological change. It is yet another story in which newly emerging opportunities prove accessible only to those with relatively privileged market access and greater initial wealth. This story plays itself out in many places, hence the importance of paying careful attention to different market structures and access the conditions and the distribution of gains across distinct subpopulations. There is a parallel, for example, in the literature on increasing food prices, which was trumpeted as a cornerstone of agricultural development strategies in the early-to-mid-1980s. Policy prescriptions built on models of farmers-as-producers suggested that poor farmers would benefit from higher food prices. This assumption unfortunately overlooked the empirical regularity pointed out by Mellor (1978), Weber et al. (1988), Barrett and Dorosh (1996) that many poor farmers are net food buyers so the distributional effects of market-based food production stimulus were more regressive than originally posited. There is likewise a large literature on technology adoption that underscores the importance of initial endowments and capital access in determining who gains from new opportunities (Feder et al., 1985).

We have focused on resource commercialization in general, but since so little work has focused on the local effects of bioprospecting[32], we close with a brief discussion of the implications of

[32] Thus far, most of the bioprospecting dialogue has focused either on the ambiguous ex ante valuation of bioprospecting (i.e. option values and firms' willingness-to-pay; Rausser and Small, 1999, 1998; Simpson, et al., 1996) or on macro issues such as equity and national benefit sharing, a cornerstone of the international Convention on Biological Diversity (Reid, 1996). The existing literature only superficially addresses local welfare effects, especially at the intra-community level. There have been a few efforts to address local impacts of bioprospecting, such as Conservation International's Tagua Initiative (see www.conservation.org/web/aboutci/strategy/tagu-aini.htm) and the case studies commissioned by the secretariat of the Convention on Biological Diversity (www.biodiv.org/chm/techno gen-res.html
cused on the distribution of benefits between the community in aggregate and outsiders, rather than local, intra-community distribution issues.

the present case to bioprospecting in particular. The local benefits from bioprospecting have been hypothesized to depend on whether extraction and processing is in situ and ongoing or in situ and single-shot (Barrett and Lybbert, 2000). Additionally, bioprospecting activities can be either market-mediated, in which case all involvement by locals is dictated by the market for the resource they control, or pre-negotiated, in which case locals are one of the negotiating parties (e.g. community or nation) agreeing on the sharing of benefits.[33] The distribution of benefits can be very different in these two forms of bioprospecting. From locals' perspective, however, neither guarantees a progressive distribution of benefits. Under market-mediated bioprospecting, asymmetries in market power might exclude locals, while in the formally negotiated version, asymmetries in political bargaining power might do the same.

Viewed as an ex post analysis of a bioprospecting success, the present case illustrates the importance of the distinction between market-mediated and pre-negotiated bioprospecting. It is precisely the dynamic market effects in the argan oil case that exclude most locals from benefiting substantially. If the locals in the AFR had been organized and negotiated with bioprospectors ex ante, using the UNESCO Biosphere Site designation as a uniting and operational structure, for example, the local benefits might have been more broadly shared and meaningful local economic development could have been a possibility. While organized ex ante negotiation of benefit sharing would hardly guarantee poverty reduction and economic development in the AFR (and would raise a set of new challenges), the outcome would likely be appreciably different under this scenario.

In conclusion, the core message of this paper is that in spite of the attractive prospects for resource commercialization in low income regions, there are no assurances that any resulting increase in value of the natural resource base will actually improve the welfare of poor host populations, especially in cases where market effects are substantial. While market-based conservation can indeed beneficially create wealth, the distributional outcome need not prove progressive or even pro-poor. The process of commercialization can readily induce changes in production, processing and distribution that exclude the poor. Thus, if the behavior of the poor matters to conservation, there is reason to question the ability of market-based strategies to translate into actual conservation, and good motivation to modify the approach accordingly.

[33] While the Convention on Biodiversity gives nations control over the genetic resources in their territory and implicitly supports the formal negotiation of benefit sharing, the guidelines provided are vague and largely unhelpful. By granting control over genetic resources to nations, the CBD also opens the way for market-mediated bioprospecting provided access to the resource is controlled (e.g. by local property rights).

Acknowledgements

The authors thank the Fulbright Program, The Moroccan–American Commission for Educational and Cultural Exchange, Dr. Daniel Sisler, the Applied Economics & Management Department at Cornell University, the Cornell Institute for International Agriculture & Development, and the Einaudi Center for International Studies, and Comparative Economic Development at Cornell University for funding this research. L'Institut Agronomique et Vétérinaire-Hassan II Rabat, the Moroccan government, the Essouira Province, and the Caid of Smimou and his staff provided key administrative and logistical support. The households participating in the survey and key informants, including Zoubida Charrouf and Bahanan Saïd, deserve acknowledgement for their cooperation and hospitality. The survey enumerators, Bahija Habib and Youssef Laaraj, did excellent work, for which we are grateful. We thank anonymous reviewers for their helpful comments and suggestions.

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