THESIS

RESOURCE PRIVATIZATION AND ENDOGENOUS PRODUCTION ACTIVITIES:

CAN PRIVATIZATION OF A NATURAL RESOURCE STOCK BENEFIT LABOR?

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ABSTRACT

RESOURCE PRIVATIZATION AND ENDOGENOUS PRODUCTION ACTIVITIES: CAN PRIVATIZATION OF A NATURAL RESOURCE STOCK BENEFIT LABOR?

Theoretically, it has been shown that privatization of open access resources results in negative impacts on economy-wide wages paid to labor when the technology used in the resource sector remains constant. Here, we examine a case where there is a change in the optimal use of a renewable resource—open access grassland used for ranching becomes private property for tourism – to show that privatization can improve economy-wide wages in theory. Whether wages improve in practice depends on the nature of the structural change and how labor is used in the privatized activity. To explore the likelihood that wages increase in practice, we use a local general equilibrium model of villages from Chilean Patagonia to investigate the impact of open access grassland privatization on factor wages and the distribution of wealth in an empirical setting.

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1. INTRODUCTION

It is a well-known theoretical result since Weitzman (1974) and Samuelson (1974) that the privatization of previously open access natural resources has a negative impact on economy wide labor wages. Privatization allows for the capture of rents previously dissipated as users enter an open access resource until returns equal the value of average product rather than the value of the marginal product (Knight 1924). As a result, privatization therefore improves efficiency, but as Weitzman shows, whether the increased rents compensate labor for their lower wages resulting from constrained access depend on the distributional mechanisms in place. As he says, the distributional effects outweigh the efficiency effects. This begs the question, are there any conditions under which the increase in economy-wide efficiency is sufficiently large to increase the economy-wide labor wages as well? In Weitzman's terminology, could the efficiency effect dominates the distributional effect given the right conditions? In particular, what if open access prevented the utilization of a resource in its most efficient productive use? Could the transition to privatization, which then enables a transition in use, lead to efficiency gains large enough that they dominate the distributional effect and leave economy-wide labor wages higher? That is the central question taken up in this paper.

Both Weitzman and Samuelson assume that the extraction of the resource is at its steady state level; the primary negative impact of open access manifests as congestion.[1] They therefore ignore a second negative feature of open access regimes: the dynamic inefficiency that occurs when a sustainable resource is extracted at rates above the natural growth rate. Baland and Bjorvatn (2013) show that in a situation in which there is a dynamic inefficiency as a result of an open access regime privatization can benefit local labor if discount rates are sufficiently low. This occurs as the far-sighted private owner extracts the resource at a permanently sustainable rate and therefore provides long-term employment to local labor.

[1] Their model can also be interpreted as the result of movement from steady-state to steady-state in a dynamic model in which resource stocks adjust downward as labor increases.

Both of these approaches focus on the two commonly discussed inefficiencies that result from open access resources: congestion inefficiencies and dynamic inefficiencies. There exists a third, less discussed inefficiency in which the most productive use of a natural resource cannot occur because of open access. This is a production inefficiency. Both labor and capital are allocated across multiple productive uses in an economy and efficiency requires that these factors be allocated such that the marginal product of a factor equalizes across all uses. Yet, the number of productive uses that resources can be put towards is determined in part by endogenous economic conditions (investment levels, resource stocks, etc.). Property rights regimes can determine what productive activities exist in an economy.

An open access regime leads to inefficient production opportunities when the resource stock is not used in the most productive way. For example, while resources are often managed to maximize rent associated with extraction, the most efficient activity may use the resource in a different way. Factors could face inefficient opportunities for two reasons: (1) because factor owners cannot protect the resource for its optimal use or (2) because factor owners cannot invest sufficiently to develop the optimal activity.

The first of these is somewhat straightforward. Imagine a case where the current use and the more efficient use can occur simultaneously but the current use negatively affects the returns of the more efficient use. No single individual can maximize their returns from the efficient use because they cannot exclude others from the resource. This problem is compounded if the congestion externality is large. Because there is no ability to exclude under open access a first mover – who shifted from the current use to the more efficient use – could see their returns completely eliminated if they were the only user who changed their use of the resource. Further, the returns of every other user increase as a result of marginally lower congestion. As a result, there is no incentive for any user to unilaterally shift to the higher use and the less efficient use of the resource could persist in equilibrium because shifting to the higher use would require coordination among users.

The second case is slightly more complex but builds on the first. The inability to exclude users from a resource makes it difficult to recoup an investment in improving that resource. Cherry, Cotten, and Jones (2013) show, in an experimental setting under certain conditions, that investment to improve a common pool resource will not occur unilaterally or cooperatively. Users only make the necessary investments in improvement if they are able to ensure, or credibly believe in, cooperation in subsequent appropriation. This builds on the extensive work by Baland and Platteau (Baland and Platteau 1997a, b, 1998b, a, 1999) regarding the impact of inequality on commons management regimes. They suggest that increasing inequality makes it more likely that endogenous structures for investment in improving the commons will occur (as increasing inequality means a single individual has the means and incentive to conduct the investment). Further, their work (Baland and Platteau 1998b) touches on the non-optimalities that can arise when open access causes a resource to be misused. Specifically, they discuss the case of herding vs. sedentary agriculture but the same inefficiency can arise in other cases. In short, the inefficiency can exist because the open access property rights regime makes it impossible for any individual to ensure they will earn returns on the necessary investment to make the more efficient productive use an option and there is no mechanism to ensure cooperation. As a result, the investment is not made and the more productive use does not become an option.

The goal of this paper is to determine whether private property rights increase economy-wide labor wages in cases where an open access property rights regime generates inefficient productive opportunities. While wages necessarily fall from resource privatization if the extraction activity stays the same, it is possible that the gains in efficiency from privatization *and* shifting to a new productive use in combination are sufficiently large to generate higher labor wages and offset the loss of unlimited access to the resource.

Privatizing a natural resource could leave labor better off if privatization results in resource activities that are labor intensive. This prevents the predicted fall in economy-wide labor demand associated with

resource privatization. In the Samuelson and Weitzman case, resource rents must be redistributed so that labor incomes do not fall; if the value marginal product of labor increases sufficiently with a change in productive activity, labor wages could be maintained even as resource rent is not redistributed.

The specific research question is three-fold: what are the conditions under which labor wages improve with a shift in the use of an open access resource, what are the conditions where privatization is necessary to achieve this result and what is the magnitude of the change in labor wages? As will be shown, the theoretical results are ambiguous. It is possible that the new productive activity does not increase labor productivity. In that case, the Weitzman/Samuelson results hold. Alternatively, there are theoretical conditions under which labor wages improve. In order to see which of these cases occurs in the real world, and to measure the magnitude of the impact, we turn to an empirical examination of this type of transition in Palena, Chile.

Palena provides an empirical example of an open access resource (grazing on open access ranchland) being privatized, which resulted in a transition to a higher value use (eco-tourism). Both activities utilize the same ranchland and both require labor inputs. Tourism also required an initial investment (and different institutional knowledge than ranching) to become a viable productive use.

The following sections include background motivations beyond the Weitzman/Samuelson literature for the study; a game theoretic examination of why users of the resource may not coordinate independently; a formal theoretical discussion of how privatization could improve local labor incomes; a short description of the empirical study area; the empirical methods used; the empirical results and policy implications; and, finally, some concluding thoughts.

2. BACKGROUND

The question of how privatization affects users of open access resources has a rich history in the economics literature. Related to this literature the environmental conservation literature has written extensively on potential impacts of resource protection on local resource users. The transition from open access to private property in the study area in Palena, Chile was driven, at least in part, by conservation objectives and the question of whether private reserves benefit local resource users.

For an excellent overview of the development of conservation theories see Vaccaro, Beltran, and Paquet (2013). The primary source of conflict in the debate has been whether conservation projects should take an integrated approach, focused on jointly increasing biodiversity and local incomes by allowing some access to conserved land (Brechin et al. 2002, Wilshusen et al. 2002), or be exclusively exclusive and prevent all local access to the land (Oates 1999). While the debate remains unresolved (Miller, Minteer, and Malan 2011), research investigating the theoretical complementarity between reserves and local incomes can contribute a deeper understanding of the mechanisms that connect conservation to local economic outcomes. The greatest criticism of exclusive reserves is that they fail as mechanisms for protecting biodiversity because they fail as mechanisms for improving local welfare.

One recent development in this field has been the growth of private protected areas (PAs). Driven in large part by eco-tourism, these private PAs may provide a new mechanism for connecting conservation to local economic benefits. In Chile there is evidence that they have increased local employment opportunities (Corcuera, Sepúlveda, and Geisse 2005). In Vietnam, private marine PAs have increased local employment as well as the size and volume of local fish populations (Svensson, Rodwell, and Attrill 2009). Private PAs have also succeeded in reducing coastal development in Costa Rica (Langholz, Lassoie, and Schelhas 2000). Further, Pegas and Castley (2014) notes that reserves need not be large to have both biodiversity and ecotourism benefits. Finally, several studies have noted that upwards of seventy-five percent of biodiversity in countries occurs outside of public PAs, on private land (Rissman et

al. 2007, Sepúlveda 2004). This anecdotal evidence suggests that the privatization of open access resources in the form of parks can in fact increase wages enough to offset access losses among local labor. Despite the anecdotal evidence in support of the idea that parks – and therefore eco-tourism – can increase local incomes there remains little economic examination of this question (Taylor et al. 2003). Among the little work that has been done, two related studies by Taylor et al. (2003) and Taylor, Hardner, and Stewart (2009) are notable for taking a similar approach to this paper. Both utilize a computable general equilibrium model to examine the impact of eco-tourism in the Galapagos. They found that while tourism had the potential to increase local incomes, inflows of labor from surrounding communities erased the gains on a per capita basis. They suggest that if these results hold universally they would pose a significant challenge to conservation based on eco-tourism operations.

Aside from the conservation related benefits to the study, the question of how to optimally manage open access resources is one that has remained unsettled since Hardin's seminal paper on the Tragedy of the Commons (Hardin 1968). Even before Hardin, Gordon (1954) suggested that providing property rights could offer an optimal management strategy in the case of common resources. He argued specifically in the context of a fishery but suggested the analysis could easily be extended to other examples of commons resources. Of particular relevance is the brief aside he provides discussing the necessity of rules regulating grazing on medieval commons. Following his result, the consensus seemed to be that in the ideal (zero transaction cost) world, the solution is simply the assignment of property rights and an allowance for Coasian bargaining (Coase 1960).

The world is not ideal however and numerous studies have shown that privatization leads to additional distributional and institutional tradeoffs between equity and efficiency when the resource users do not receive the ownership rights in a privatized system (Weitzman, Samuelson, Baland, etc.). Not least among the challenges of privatization is that the distributional impacts of privatization tend to fall most heavily on the poor in developing countries (Béné, Hersoug, and Allison 2010). In recognition of the fact

that full privatization may have negative impacts a number of alternative management regimes, which do not have a single, external owner, have been proposed. Again in the context of fisheries, but with analogues in other resources, these range from the "regulated open access" of Homans and Wilen (1997) to the individual tradable quotas discussed, among others, in Wilen (2000). The key feature of many of these modified privatized solutions is that they provide some degree of property rights to existing users, rather than concentrating the rights in the hands of a single individual. Distributing rights in this way ensures that rents are also distributed to existing users and, as a result, solves part of the problem shown by Weitzman. As labor incomes decline from the move to the VMP this decline can be offset by the new income from the scarcity rents (Terrebonne 1993). Heaps (2003) echoes this conclusion but shows that heterogeneity among fisherman means that not all incomes improve. Adding to the debate is the work by Ostrom which suggests communities can often manage an open access resource efficiently without the aid of private property rights given the right conditions (Ostrom 2010).[2]

Despite the preponderance of literature examining aspects of open access commons, there remain areas to contribute (Stavins 2011). One is a question of under what conditions the community will self-organize in the style of Ostrom to provide investment to avoid the suboptimal use inefficiency caused by open access resources. If communities organized in such a way in all cases it would obviate the need for private property (as well as the inefficiency itself). The second contribution is an examination of the conditions under which the Samuelson/Weitzman effect (declining income for labor) is offset by increases in labor productivity. Or, in Weitzman's words, the conditions under with the efficiency effects dominate the distributional effects. Demonstrating that such an offset can occur provides some economic justification for private property rights in previously open access resources.

[2] The right conditions include significant devolution of rights to the community, communication among community members, and the ability exclude non-community members.

Given these two specific questions, it is worth noting two additional papers. The first is by Hannesson (2010) in which he demonstrates that welfare may improve through privatization in a general equilibrium setting even without rent redistribution. The crux of his argument is the requirement, not met by Weitzman or Samuelson, that a resource "be so overexploited that a reduction in the input of the variable factor would increase production" thereby increasing labor productivity. The second is by De Meza and Gould (1987) who, similarly to both Hannesson (2010) and Baland and Bjorvatn (2013) provide a specific example of where privatization leads to higher resource stocks and therefore higher labor wages. However, unlike Weitzman their model is not necessarily always at steady state. Indeed, they suggest that the inefficincy of the open access case is that the resource could be fished to extinction – explicitly not a steady-state condition. Thus, while their paper offers evidence that the Weitzman/Samuelson conclusions are not universally true, they do not provide a steady-state condition under which labor incomes improve. That is one goal of this paper: provide a theoretical condition under which labor incomes increase in a new steady-state.

3. A GAME THEORY APPROACH TO EXPLAIN NON-COOPERATION

If it is the case that the Samuelson/Weitzman effect can be offset by shifting to a more efficient productive use through investment alone, it begs the question of why the local users do not organize themselves to restrict access. The ability of communities to organize to overcome common pool resource (CPR) problems has been demonstrated in many cases around the world (Fehr and Gachter 2000, Ostrom 2000) and so it is no longer sufficient to point to individually rational free-riders as the reason that communities do not organize to realize the increased rents that come with a managed CPR.

In response, many possible explanations for why some communities successfully organize to increase rents have been tested in experimental settings. Cheap talk (the ability to promise cooperation but with no enforcement mechanism) was found to increase rents above the rents observed without cheap talk and above the levels predicted by game theory in Ostrom (2006); while collective choice and voting were shown to increase efficiency of appropriation (allocation) but had varying distributional effects in Walker et al. (2000). Vollan and Ostrom (2010) review two studies which demonstrate, with field experiments, that increasing the number of conditional cooperators – even if the total falls short of 100% of the group – can avoid the tragedy of the commons.

In all of these cases, and in those discussed above, the assumption was made that the productive use remained the same before and after privatization; if an open access ranchland was used for grazing prior to privatization, it simply became a private grazing operation after property rights were assigned. The difference in efficiency came from changing the rate at which the resource was extracted, which generated a corresponding increase in rents. This leaves untouched an important aspect of privatization: that it allows for differential utilization of the resource at a potentially higher value productive use as compared to the open access solution.

For example, forests provide multiple sources of income to users. The obvious source of revenue is clearing the forest for timber or agriculture. These activities are the primary drivers of deforestation in tropical countries (Ferretti-Gallon and Busch 2014) and can result from insecure property rights over the forest. Alternatively, Liscow (2013) argues that it is in fact secure property rights which drive deforestation by increasing investment and therefore agricultural productivity. The general principle is simple however. Forest users clear the forest because clearing the land provides some measure of tenure and control over the resource by preventing others from moving first and capturing the rent embodied in the standing trees. Thus, clearing an open access forest has significant first mover advantages.

In the context of a world where forests can generate revenue from Reduced Emissions from Deforestation and Degradation (REDD+) programs, clearing the forest can also be a significant inefficiency. Payments to illegal loggers are often a fraction of the price that logs fetch on the global market (Kremen et al. 1999). In contrast, REDD+ holds the potential for a massive influx of funds to leave the trees standing (Phelps, Webb, and Agrawal 2010). However, leaving trees standing under uncertain property rights regimes opens the door for free-riding individuals to, at least selectively, harvest trees to receive both the REDD+ benefits and the timber benefits. Doing so on a large scale eliminates the potential REDD+ benefits. As a result, the open access property regime introduces inefficiency by preventing the utilization of the resource at a higher value production function.

In the context of this paper, the resources in question are those embodied in a mixed montane grassland forest that could be used to generate revenue in either a ranching or tourism operation. In the open access case, however, the inability to exclude other users makes it nearly impossible to realistically operate a tourism business on the property. Tourists are unlikely to pay to visit an area that is overcrowded by others grazing animals. In this case, the open access nature of the resource precludes the use of the resource in a potentially higher value use. A further complication is introduced if the utilization of the resource for tourism requires an upfront capital investment. No individual is likely to make that

investment in the open access case if they cannot reasonably expect to exclude others from grazing while they bring tourists to the area. Privatization incentivizes owners to exclude workers from the lower value activity while at the same time making investments in the higher value activity. A private owner can ensure no others graze the land while tourists visit and so can be assured of earning back the initial capital investment given that the investment makes sense otherwise.

In the example above it seems reasonable to expect that, in at least some locations, tourism will result in a higher sustainable marginal return to labor than ranching. Because open access makes it individually optimal for users to capture value through a lower value productive use – because of the inability to exclude other users –it leads to the suboptimal economic activity.

Like the temporal inefficiency explored by Baland and Bjorvatn (2013), this suboptimal allocation of resources is a problem that could be solved either by privatization or by community organization. However, it is unclear whether a community would be able to overcome the joint challenges of coordinating the initial capital investment and restricting subsequent access to levels compatible with tourism.

Previous game theory approaches to CPR problems have examined similar questions about both provision of resources and the decision to appropriate those resources in an open access setting but, to my knowledge, no one has considered both together except for Cherry, Cotten, and Jones (2013). This consideration is relevant to this study because the extent to which the cooperation of communities to provide investment to reach a more productive use of open access resources impacts their ability to cooperate in reaping the benefits of that more productive use may determine the magnitude of the benefits of privatization. If a community can cooperate on their own there is little need for privatization.

Previous research on the impact of direct involvement in the provision of resources has yielded inconclusive results. It seems that two opposite effects drive behavior with ultimate actions determined by whichever effect dominates. The first effect is an "exhaustion of cooperation" effect whereby cooperation in one stage leads to less in subsequent stages. On the other hand, there also appears to be an "enhancement of cooperation" effect where cooperation in the first stage makes cooperation in subsequent stages more likely.

Empirically, several experimental studies have shown that exerting effort to obtain a resource leads to less cooperation in subsequent public goods games (Cherry, Frykblom, and Shogren 2002, Harrison 2007, Janssen, Anderies, and Joshi 2011). On the other hand, there is also empirical evidence that cooperation in the generation of resources can lead to additional cooperation in the allocation of that resource (Vyrastekova and van Soest 2003). In the same vein Bchir and Willinger (2012) find that being required to pay a membership fee to get access to a public good increases provision of that good. If the side of the literature that suggests working for a resource results in less subsequent cooperation is correct, that suggests that communities would struggle to cooperate to limit access after making an initial capital investment to develop tourism. Of course, if the cooperative side of the literature turns out to be correct, the initial requirement of a group-wide capital outlay should make restricting access easier.

Another relevant strand of the game-theoretic literature on CPR is that of examining the influence of public bads, as opposed to public goods. The second decision facing individuals in the example above, whether to contribute to tourism operations or to graze cattle even though a tourism operation may exist is not simply a question of public goods provision. Contributions to tourism are a public good, but the second decision – whether to graze cattle – is a decision to contribute (or not) to a public bad or external cost; individuals may not suffer from grazing cattle if they are the only ranchers but it imposes an external cost on each individual producing tourism. Work by Delaney and Jacobson (2014) shows that in-group altruism may lead to lower levels of public bad 'provision.' In this case, whether an individual chooses to

graze cattle may ultimately depend on the size of this effect and whether that individual feels they are part of the tourism in-group. In line with the work suggesting cooperation in provision of a resource leads to cooperation in its appropriation, the decision to graze cattle may depend on whether an individual contributes to the initial capital investment.

4. FORMAL THEORY OF PRODUCTION INEFFICIENCY

This section introduces the formal model used in the paper. The first section will formalize the game described above to demonstrate theoretical conditions under which there could be a failure to reach the investment threshold without a private owner. The second section expands the model to provide theoretical conditions under which reaching the threshold would improve wage incomes for providers of labor.

4.1: THEORY OF THE GAME

While the question of whether individuals would be able to solve the open access problem to provide tourism is ultimately an empirical one that is not answered here, we build on the model developed by Cherry, Cotten, and Jones (2013), which is based on the standard CPR game developed in Walker, Gardner, and Ostrom (1990), to explore analytical solutions to the problem. In other words, what are the conditions under which individuals are likely to collectively solve the problem to (1) reach the investment threshold for tourism and (2) contribute labor to tourism as opposed to ranching? What are the conditions under which privatization does (or does not) yield benefits.

In this framework, each agent is faced with a series of options for what to do with their labor. The highest yielding option that they can contribute to is a tourism option (high yield CPR). However, they receive returns from tourism whether or not they contribute labor as a member of the community. Further, in order for tourism to be one of their options, they must first contribute labor to building the infrastructure necessary for tourism. Whether they choose to provide this infrastructure or not, they have the option to provide labor to a second, lower yielding productive activity in ranching (low yield CPR). However, the more people that contribute to ranching, the lower the individual returns. Further, any contribution to ranching reduces the collective returns to tourism (if the necessary investment in infrastructure was made). Finally, they always have the option to allocate labor to a private, non-resource intensive activity (private).

In this setup, *n* users, who maximize utility equivalent to returns to their labor, make a decision in the first stage about how much to contribute to reaching an investment threshold. In the second stage they must decide how to allocate their remaining resources between a private returns option and a CPR option. The extension to the Cherry et al model is what happens if the threshold is reached in the first stage. In that case the user has an additional option, which is to contribute to a second, higher yield, public good option that relies on the CPR. Notably, none of the options are mutually exclusive in this case; an individual could chose to contribute to any or all of the three options. Indeed, the crucial challenge facing the group is the fact that a rational utility maximizing agent should contribute to achieving the threshold but contribute nothing individually to the higher yield public good option; to be a free-rider. However, the socially optimal solution is for all agents to contribute all of their labor to the public good option.

4.1.1: STAGE I: INVESTMENT

At the beginning of each period, each agent decides how much of their original endowment ($\bar{c}$) to contribute (c) towards reaching the initial investment threshold (T). If aggregate contributions exceed T then the agents will have the option to contribute to the production of tourism in the second round, if aggregate contributions do not exceed T each individual c is lost. In the case that T is not met the agents only have the option of appropriating from the CPR or putting their resources towards private returns in the second round.

The threshold T is known to the agents, as is the form of the production functions associated with tourism, the CPR, and the private return in stage two. Total returns for each agent are defined as $R(\sum_{i=1}^{n} c_i)$ with $R_T(\sum_{i=1}^{n} c_i \geq T)$ in the case the threshold is met and $R_0(\sum_{i=1}^{n} c_i \leq T)$ in the case it is not. An agent i will contribute as long as $R_T - (R_0 + c_i) \geq 0$ (assuming that indifferent agents contribute). Whether this inequality holds depends both on the shape of the production functions in stage two and the behavior of the other agents in the second stage. Independent of this behavior, however, there are only two possible

symmetric Nash equilibria (NE) in the first stage: $(\sum_{i=1}^{n} c_i) = 0$ or$(\sum_{i=1}^{n} c_i) = T$. Whether the second is a NE depends on what happens in stage two.

4.1.2: STAGE II: APPROPRIATION

Following Cherry et al (2013), agents simultaneously allocate their remaining endowment between options as defined by whether the threshold was achieved in period one. In R_0 the first option for contributions is an individual private production function that takes the form $y_i = f(z_i)$ where *y* is the return to a contribution of labor in the private productive use z_i. By assumption $f' > 0$ and $f'' < 0$.

The second option in R_0 is to appropriate part of the CPR via ranching. The aggregate return of the CPR, $G(A, S, b)$, is defined as a function of *S*, the exogenous stock of the resource, *b*, an exogenous resource parameter, and aggregate appropriations A=$\sum_{i=1}^{n} a_i$, where a_i can be thought of as the amount of labor each individual contributes to extracting resources from the CPR (in the same units as k_i). By assumption the following are true of$G(A, S, b)$:

$$\frac{\partial G(A,S,b)}{\partial S} \geq 0 \; and \; \frac{\partial G(A,S,b)}{\partial S \partial S} = 0 \qquad \textbf{1 \& 2}$$

$$\frac{\partial G(A,S,b)}{\partial b} \geq 0 \; and \; \frac{\partial G(A,S,b)}{\partial b \partial b} = 0 \qquad \textbf{3 \& 4}$$

$$\frac{\partial G(A,S,b)}{\partial A} = h(A,S,b) and \; \frac{\partial G(A,S,b)}{\partial A \partial A} \leq 0 \qquad \textbf{5 \& 6}$$

Where $h(A, S, b)$ depends on the size of the stock, the aggregate contributions and the size of *b* and cannot be signed *a priori*. Individual returns to the CPR are determined by the aggregate returns and the amount of labor that each individual contributes to the CPR:

$$g_i = \frac{a_i}{A} G(A, S, b) \qquad \textbf{7}$$

In R_T, when the threshold is reached, the agents have the additional option to contribute labor to a higher value productive use that takes the features of a public good game and represents a real-world tourist

operation. Labor contributed to this productive use is denoted l_i. The aggregate returns to the tourist operation are defined as a function $K(L, A, S, x)$ of the resource stock, aggregate tourist labor contributions (L=$\sum_{i=1}^{n} l_i$), and the amount of grazing that also takes place where *x* is an exogenous parameter that reflects the negative impact of grazing on tourism. It seems reasonable to assume that grazing will not have a 1:1 negative impact on tourism – that is for every one unit increase in aggregate contributions to grazing there will not be a one unit decrease in tourism revenue. The *x* parameter thus scales the negative impact of *A* and ranges from zero to one. The following are true by assumption:[3]

$$\frac{\partial K(L,A,S,x)}{\partial A} \leq 0 \; and \; \frac{\partial K(L,A,S,x)}{\partial A \partial A} = 0 \qquad \textbf{8} \; \& \; \textbf{9}$$

$$\frac{\partial K(L,A,S,x)}{\partial S} = Q(L,A,x) \; and \; \frac{\partial K(L,A,S,x)}{\partial S \partial S} = 0 \qquad \textbf{10} \; \& \; \textbf{11}$$

$$\frac{\partial K(L,A,S,x)}{\partial L} = M(S) \geq 0 \; and \; \frac{\partial K(L,A,S,x)}{\partial L \partial L} = 0 \qquad \textbf{12} \; \& \; \textbf{13}$$

$$\frac{\partial K(L,A,S,x)}{\partial x} \leq 0 \; and \; \frac{\partial K(L,A,S,x)}{\partial x \partial x} = 0 \qquad \textbf{14} \; \& \; \textbf{15}$$

And individual returns to tourism are defined as:

$$k_i = \frac{K(L,A,S,x)}{n} \qquad \textbf{16}$$

Given this formulation, tourism is harmed by continued grazing (through **8**), and so $K(L, A, S, x)$ is maximized if, for every agent, $l_i = e_i$ where e_i is agent *i*'s endowment because $K(L, A, S, x)$ is strictly

[3] One may note that **13** implies constant returns to labor in tourism. This may not be a reasonable assumption. If one instead assumes decreasing returns then the results derived below are not universally true. However, there still exist sets of parameter values and formulations under which the conclusions hold. All that is necessary is that the socially optimal solution requires all labor be put towards tourism. It is easier to derive situations in which this is the case if there are constant returns to labor but constant returns to labor are not a necessary condition for this result.

increasing in L. However, agents maximize their total income function, not just **16**. Agent i optimizes the following equation to determine their income when the threshold is met (R_T):

$$\max_{a_i, l_i, z_i} \pi_i = y_i + k_i + g_i \quad \textbf{17}$$

And if the threshold is not met, then (R_0) they optimize:

$$\max_{a_i, z_i} \pi_i = y_i + g_i \quad \textbf{18}$$

Thus, agents compare the difference in payoffs between R_0 and R_T when deciding whether to make a contribution in the first stage. Depending on the specific formulations of $f(z_i), K(L, A, S, x)$ and $G(A, S, b)$ there are many possible outcomes of this decision process. Two are considered here:

1. R_0(**18**) is strictly greater than R_T (**17**). This case is dismissed here as uninteresting. If R_0 is strictly greater than R_T there is no inefficiency caused by the current productive use.
2. R_0 is strictly less than R_T given the NE levels of z_i, a_i and l_i. Additionally, the socially optimal level of l_i is for $l_i = e_i$ but this is not the symmetric NE. This is tantamount to saying that **17** becomes:

$$\max_{a_i, l_i} \pi_i = k_i + g_i \quad \textbf{19}$$

Because for R_T to be strictly greater than R_0 it must be the case that $\frac{\partial k_i}{\partial l_i} > \frac{\partial y_i}{\partial z_i}$ and, as a result, no rational agent would contribute to y_i instead of k_i. Further, because the social optimum is not a symmetric NE, it implies that in a situation with rationally self-interested agents, an inefficiency due to the productive use exists. Some labor will be put towards ranching even though everyone could be made better off by placing all labor in tourism. This results because agents play a strategy which maximizes their expected returns *given* the anticipated actions of other agents.

It is a necessary but not sufficient condition for a productive use inefficiency to exist that the second of these two cases be in force. R_T being strictly greater than R_0 only implies that reaching R_T would be more efficient. In order for an inefficiency to exist, it must be the case that agents will not, at least in some cases, cooperate to reach R_T. Mathematically, **20** must be true.

$$\pi_i^{R_T} - \frac{T}{n} > \pi_i^{R_0} \qquad \textbf{20}$$

Whether **20** is true or not depends on the specific formulation. However, there are cases in which **20** will not be true in the open access case but would be true if the resource was privatized. This result arises because in the symmetric NE described in Case 2 above, the level of ranching is non-zero. In the private case the level of ranching will be zero as the private owner can limit access to the land. In that case the payoffs to the private tourism case are higher than the payoffs to tourism in the symmetrically cooperative case, which allows for **20** to be true for larger values of *T*.

To illustrate, consider the following problem facing the private owner of the open access land from the above scenarios:

$$\max_{a_i, l_i} \pi_i^{P,R_T} = K(L, A, S, x) + G(A, S, b) - T \qquad \textbf{21a}$$

$$\max_{a_i} \pi_i^{P,R_0} = f(z_i) + G(A, S, b) \qquad \textbf{21b}$$

21a & **21b** reflect the fact that the private owner not only has full control over how the land is used, hence *L* and *A* become l_i and a_i, but note also that all of the returns to tourism go to the private owner. **21a** reflects R_T and **21b** reflects R_0. While c_i is now *T* reflecting the fact that the private owner must pay the full threshold, the optimal value of **21a** will be strictly greater than the left hand side of **20** under any formulations such that the socially optimal solution requires $l_i = e_i$. As a result, there exists a case such that:

$$\pi_i^{P,R_T} - \pi_i^{P,R_0} \geq 0 > \pi_i^{R_T} - \pi_i^{R_0} - \frac{T}{n} \quad \textbf{22}$$

For the same value T. This result comes from two facts about the private landowner relative to the open access users. The first is that the private landowner realizes all of the benefits of an activity rather than $\frac{1}{n}$ of the benefits. The second, and more important, is that the private landowner has both the incentive (because of the first fact) and the ability (because of property rights) to exclude other users and thus avoid the public bad nature of ranching. Thus, there is a parameter set under which the community will not organize to provide tourism in equilibrium, despite it being socially optimal, but where a private owner will invest in a tourist operation.

4.1.3: GAME DISCUSSION

It is in this case – where local labor would not cooperate because of a high threshold value and the inability to exclude ranching but where exclusive tourism is more productive than combined tourism and ranching – that the productive use inefficiency of the commons becomes most obvious and where privatization is most beneficial.[4]

We now investigate the impact of parameters on the likelihood that a group of resource users has the incentive to self-organize. To begin, payoffs are decreasing in *T*; as the threshold increases it cuts directly into the improved production from tourism by directly reducing the amount of resources available to contribute to tourism in the second stage. Increasing the endowment, however, increases payoffs. This results because the marginal returns to tourism are higher than or equal to either ranching or the private

[4] There are, of course, other reasons why the private analogue to equation 10 might be positive when equation 10 is negative. Perhaps most obvious among this is the multi-period case in which the threshold is met by borrowing. If the private owner has a lower cost of borrowing than cooperative local labor, then the private analogue to equation 10 will be positive for some set of parameters such that equation 10 is negative.

Further, the parameter space in which 11 is true increases as there is a cost to organizing. Here we assume that local users could costlessly organize. If they cannot (a reasonable assumption) that creates a wedge between the private *T* and the *T* faced by the local users. The size of the parameter space increases with this wedge.

activity. As a result, increasing endowment directly increases the amount of resource contributed to tourism and so increases payoffs. The exogenous parameters *x* and *b* have opposite effects. Payoffs are increasing in *b* as this increases the congestion costs of ranching and therefore reduces the contribution to ranching in the symmetric NE. The impact on payoffs comes by reducing the magnitude of the public bad effect that ranching has on tourism and directly increasing tourism earnings by shifting labor into tourism. On the other hand, payoffs are decreasing in *x* as this increases the magnitude of the public bad effect on tourism. Although there is a shift away from ranching in the symmetric NE, it is not large enough to offset the magnified impact of the public bad.

Finally, payoffs are increasing in the parameters *S* and *n*. It is intuitive that payoffs increase as stock increases – both production functions rely on the level of stock and the marginal returns to tourism are greater. More interestingly, if stock is scaled as a percent of the total carrying capacity, payoffs increase as the percent of capacity approaches 100. This is notable because, as the theory section points out, the tourism case is likely to lead to steady-state levels of resource stock that approach or reach the carrying capacity of the land. That payoffs are increasing in *n* is perhaps the most counter-intuitive result. As *n* increases in the symmetric NE case the equilibrium contribution to ranching declines which increases the quantity of labor in tourism. Because tourism revenue is strictly increasing in labor, this increase generates strictly increasing returns as the magnitude of the public bad effect from ranching remains the same. This result is surprising as it suggests that larger communities may be more likely to organize to achieve a threshold and improve production on an open access resource. However, this result depends heavily on the agents playing a symmetric NE strategy and having an exogenous wage in $f(z_i)$. If they do not, and agents over-contribute labor to ranching, the payoffs will quickly turn negative as *n* increases.

Reviewing the impact that these individual variables have on the parameterized model suggests a few general guidelines. Privatization will be most useful in situations in which the public bad nature of the open access activity is severe. Lower local endowments or a high threshold also increase the likelihood that privatization would be beneficial. The stock level has a somewhat ambiguous effect. A higher stock

means that locals may be more likely to organize on their own, as it increases payoffs, but privatization may allow a private owner to more easily remove land from production in order to allow stock to recover and thus realize the higher payoffs that come with a higher stock level. *N* also has an ambiguous effect. While increasing *n* increases payoffs – increasing the likelihood of organizing and thus decreasing payoffs to privatization – it also increases the unconsidered costs to organizing and so may make organizing less likely, thus increasing the benefits of privatization.

In the case study examined, in Palena, the pre-tourism situation exhibited all of the features described above that suggest organizing would be a challenge. The required investment to transition to tourism was very large, indicating a high threshold; the existing biomass stock level was low as a result of fires that damaged the soil; and the public bad nature of ranching was very severe as the prime location for locating most of the tourist infrastructure is the same valley floor that held the cattle. This public bad was further exacerbated by cattle entering the river uncontrolled and harming the native trout fishery (a prime tourist draw). Thus, anecdotally – with empirical confirmation by the fact that the transition to tourism did not and, by local accounts, would not have occurred – the conditions for privatization to be most positive did exist in Palena.

The goal of this section was to illustrate some cases under which community organization may not occur even if it would be socially optimal. In those cases, privatization can improve overall incomes. In illustrating this, the hope was to answer the apparently obvious question, 'if shifting the production function benefited local labor, why wouldn't they organize to do it on their own?' In other words, to illustrate that there are not just the theoretical conditions for a productive use inefficiency resulting from open access but also that local communities may struggle to solve this inefficiency on their own. As a result, their does exist a role for privatization to improve incomes.

In addition to the issues discussed in this section there are other reasons why a community may not organize to overcome the inefficiency. Most notably credit constraints may preclude the investment in

achieving the threshold even if the community agreed to cooperate in reaching the threshold and providing tourism. Further, and more fundamentally, a community historically dependent on ranching for income may not have the necessary knowledge, skills and connections to develop and international tourism destination. This knowledge gap is likely a more elementary obstacle – and clear illustration of the need for outside assistance either in the form of privatization or NGO involvement – than any cooperation challenges. These types of obstacles are important but are not especially related to the property rights regime and so are left undiscussed here as being beyond the scope of this paper. The focus was on cooperation challenges because they are related to the behavior of the actors involved and could impede the development of a tourism operation given open access property rights even if no other obstacle existed. However, the focus here was on cooperative challenges because these, unlike credit constraints or knowledge gaps, are directly related to the property rights regime.

The next section continues with the formulation above to show the theoretical conditions under which the transition to a more efficient productive use can generate efficiency effects that dominate the distributional effects. Because these theoretical results are ultimately ambiguous – there are cases in which the efficiency effects do and do not dominate – the final sections present the empirical model used to assess whether privatization can improve local labor incomes.

4.2: Gains from Changing Productive Use

This section lays out the formal model of how privatization of the resource can improve labor incomes. We begin here with the agents' choice to work in the CPR. Individual returns to labor in the CPR are defined in **7** and because there are no restrictions on access to the resource the relevant consideration is the average return to labor (g_i^a), which is equal to $\frac{g_i}{a_i}$ and is also equal to the economy-wide wage (w) under efficiency. By assumption, $\frac{\partial g_i}{\partial a_i} < g_i^a$. Thus, in equilibrium labor will chose to work in the CPR until the average returns are equivalent to the returns in the private sector as defined by **23**.

$$p_y \frac{\partial f(z_i)}{\partial z_i} = p_g g_i^a \quad \textbf{23}$$

Where p_g is the price of the good produced on the open access resource.

It was Samuelson's and Weitzman's contribution to show that privatizing the resource, changing the right hand side of **23** to g_i' will necessarily make labor worse off in terms of income than before. However, as noted above, they assume that production function for the privatized resource remains the same as the open access. In other words, the marginal returns to the privatized resource are in fact g_i'. In this paper we introduce an alternative; that is, the privatization of the resource allows for it to be used in the alternative production function where output is defined by **8-16**. Additionally, $\frac{\partial K}{\partial L} > \frac{\partial g_i}{\partial a_i}$. Because the private owner sets the wage in activity t equal to the marginal product of labor $\frac{\partial K}{\partial L}$, this implies that the equilibrium allocation of labor is defined by equation 24.

$$p_y \frac{\partial f(z_i)}{\partial z_i} = p_t \frac{\partial K}{\partial L} \quad \textbf{24}$$

Compare this to the solution after privatization if the productive use remained the same:

$$p_y \frac{\partial f(z_i)}{\partial z_i} = p_g \frac{\partial g}{\partial L} \quad \textbf{25}$$

Equation **25** defines the solution to the Weitzman/Samuelson problem. Because $\frac{\partial g_i}{\partial a_i} < g_i^a$ due to concavity, labor wages decline. However, in this formulation because $\frac{\partial K}{\partial L}$ is greater than $\frac{\partial g}{\partial L}$ by assumption, it is no longer Weitzman's and Samuelson's results no longer hold. Rather, the question of whether labor is better off under privatization is determined by the relationship between $\frac{\partial K}{\partial L}$ and g_i^a. *A priori* it is not possible to say which will be greater and thus the theoretical results are ambiguous.

Although it is not possible to say for certain whether labor incomes will improve based on the general form, there are a number observations which can be made about the conditions under which labor

incomes will increase. Labor incomes improve if $p_g \frac{g_i}{a_i} < p_t \frac{\partial K}{\partial L}$. This could occur for a number of reasons. First, if the new production activity is more labor intensive than the existing open access activity. Alternatively, if the final price of the new product is sufficiently greater than the price of the open access product, even an activity that is less labor intensive could ultimately improve labor incomes.[5] Referring to these two conditions generally as the size of the structural change leads to the first condition under which privatization can improve labor incomes, which is that the size of the structural change is sufficiently large.

The next condition under which labor incomes could improve relates to the resource itself. Regardless of labor demand across both activities, labor income could improve if the intensity of resource use declines in the privatized case. That is, if $g_i(S) < t_i(S)$ then labor incomes may improve under privatization. This occurs as a greater level of output can be produced given a set resource level, labor input and final price. Whether labor incomes improve in this case depends on how the additional rent from the resource stock is distributed.

Alternatively, labor incomes may also increase under privatization if the consumptive intensity of production relative to the resource declines. This allows for an increase in the steady-state level of the resource and a corresponding increase in total output ($S_g < S_t$ and, therefore, $G(S_g, \bar{A}, \bar{b}) < K(S_t, \bar{L}, \bar{A}, \bar{x})$). In an extreme case, if the consumptive resource use declines all the way to zero, as could happen if the resource is used entirely non-consumptively in the privatized case, labor will be strictly better off if the steady-state level of the resource in open access is sufficiently far below the maximum level of the resource and demand for labor in the privatized case is non-zero. This occurs because in this extreme case privatization allows the resource to regenerate to its maximum level, which becomes the

[5] This refers to aggregate labor incomes. A less labor intensive activity obviously may cause some individuals to receive less in wages.

new steady-state. If the difference in steady-states is large enough, the increased production is sufficient to offset declines in the level of labor wages. In other words:

$$S_t^{ss} = \bar{S} \gg S_g^{ss} \; such \; that \; G\left(S_g^{ss}, \bar{A}, \bar{b}\right) < K(S_t^{ss}, \bar{L}, \bar{A}, \bar{x}) \; and \; so \; \frac{G\left(S_g^{ss}, \bar{A}, \bar{b}\right)}{a_i} < \frac{\partial K(S_t^{ss}, \bar{L}, \bar{A}, \bar{x})}{\partial L}$$

Thus, the second condition under which labor incomes can improve is defined by the level of intensity at which the resource is used in the private case. At low resource intensities relative to the open access case, labor incomes can improve.

4.2.1: Discussion of Changing Productive Use

This leaves us with two conditions under which labor incomes could improve with privatization stemming from a change in the production function. The first depends on the size of the change in the structure of the production function and prices. That is, if the new activity requires more or generates a product of greater value than the open access production function, the marginal product of labor in the privatized case will be greater than the average product in the open access case. Labor income will improve.

The second condition depends on how intensely the resource is used in each scenario, namely how changing the resource stock effects the value of tourism. If the privatized case uses the resource less intensively, and so generates more product for a given steady-state level of use, labor incomes will improve *certeris paribus*. The same is also the case if the consumptive intensity of the resource declines, which allows for a higher steady-state level of production. The extreme case is when the resource is allowed to regenerate fully.

Graphically the situation can be represented by the following two figures. Figure I illustrates the Weitzman/Samuelson result where privatization causes a shift from private wage equilibrating with the average product of labor on the open access resource to the marginal product of labor. This reduces total

wages and means labor incomes decline. Note that because the productive use of the open access remains the same under both property rights regimes the VMP and VAP curves remain constant – all that privatization gains is a more efficient allocation of labor as the VMPs are set equal.

One can see that as the private owner shifts from the avg. Product of labor to the marginal product of labor the wage rate, represented by the intersection of the heavy line at the top of the larger box (*w),* shifts down (*w'*). This results in a shift down of the private wage rate, movement of labor into the private activity because more labor is demanded at a lower cost, and declines in wages. Whether a larger or smaller amount of labor is employed depends on the relative slopes of the private wage curve and the CPR productivity curves. As drawn the total amount of labor declines.

Figure I: Privatization Leads to Declines in Labor Income

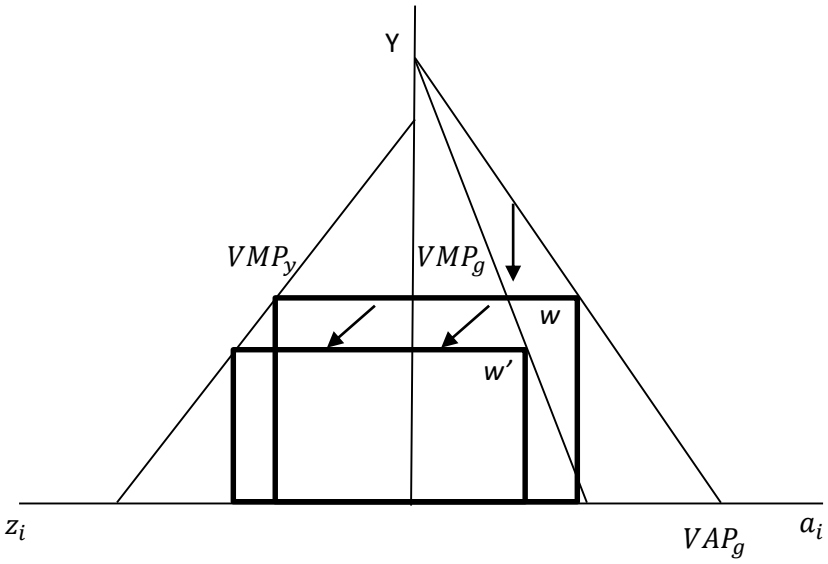
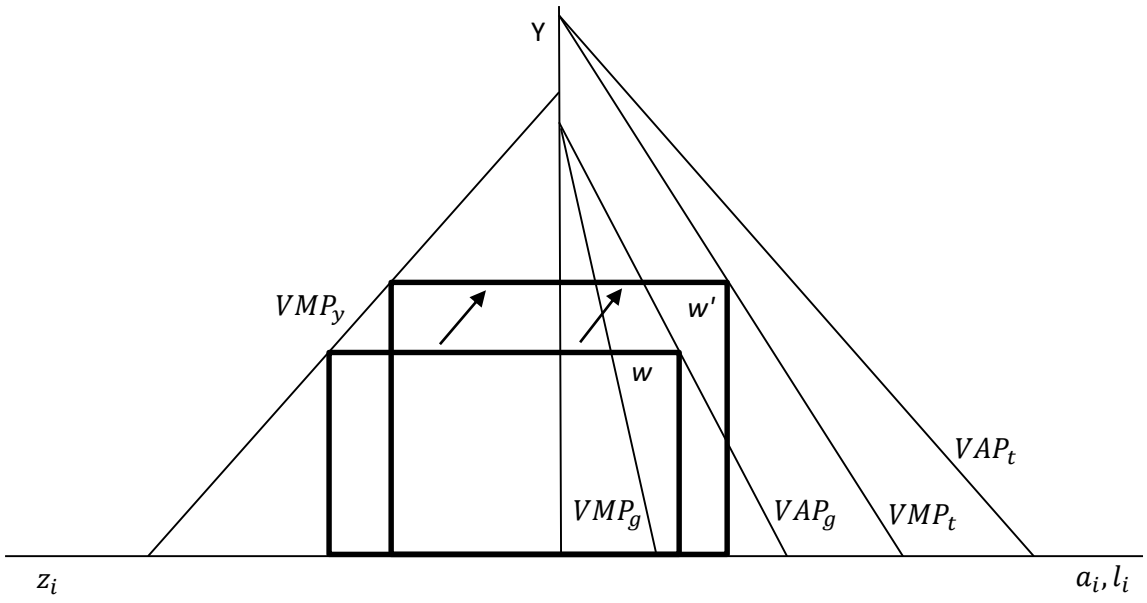


Figure II represents the theoretical possibility laid out here. That is, the privatization leads to a higher production function as the CPR is employed in a more productive activity and so, despite the wage rate still being equal to the marginal product of labor, labor incomes improve (shifting from *w* to *w''*).

From Figure II the wage rate increases as the new private owner shifts from the old avg. product of labor (VAP_g) to the new marginal product of labor (VMP_t) denoted by the shift up of the top line in the heavy

black box. This causes the wage rate in the CPR to increase, which increases the private wage rate, and demand for labor in the private activity falls at the new higher cost. As drawn here the increase in production function induces additional labor demand in the previously CPR – this need not be the case – and the overall increase in labor income is positive (as the narrow, tall box is larger than the wide short box).

Figure II: Labor Incomes Increase with Privatization



This concludes the theoretical examination of the problem. Two main points have been demonstrated in this section: First, there are conditions under which a community could benefit from shifting the productive use of an open access resource but will not do so because of the cost and the difficulty of ensuring cooperation. In these cases privatizing the resources can make it possible to achieve the more efficient productive use. Second, open access does, under some conditions, generate productive use inefficiency. That is, the open access resource could be used more productively in a different use but that use is precluded by the open access regime. In these cases it may be possible for privatization of the

resource to improve labor incomes. However, the actual effect of privatization depends on the relative sizes of the old VAP and new VMP and, as a result, is theoretically ambiguous.

Thus, in order to examine the sign and magnitude of this impact in a real world setting we now turn to an empirical application where functional forms for each rights regime are specified and calibrated to existing data. These functions are parameterized with values from Chilean Patagonia and a local general equilibrium model is solved to determine if any of the conditions above are met in a real-world example.

5. EMPIRICAL SETTING

The empirical model is calibrated to data from the Los Lagos region of Chile. Specifically, the scope of this analysis is the area on the border with Argentina directly around the village of Palena. Although Palena is located in the Los Lagos region, it is economically and culturally far more similar to the Aysen region just to the south. This area of the country is one of the poorest, with nearly 60% of families receiving subsidies from the government (Delgado, Sepúlveda, and Marín 2013).

It was selected as the location for the study because of a unique conservation project taking place outside of Palena. In 1996, a Chilean/American conservation organization, Patagonia Sur, purchased 7,000 acres of land outside the village that had previously been used as de facto open access ranchland by ranchers in the area.[6] Patagonia Sur has since transformed the property into a subscription based tourism operation employing local community members as guides and labor on the property.

Patagonia Sur's operations in Palena offer the perfect opportunity to study the impacts on local labor of transitioning an open access resource to private ownership and then changing the resource production process; this is exactly what occurred in Palena.

To determine the actual impact on labor incomes of the conversion of 7,000 acres from open access ranchland to a private tourism operation we use a simple general equilibrium model as in (Manning, Taylor, and Wilen 2013). For a full review of the theory behind these types of household models and examples of the ways in which they've been used, see Taylor and Adelman (2003). The primary innovation in this paper is the addition of the more efficient productive use of the resource (tourism) whose availability as an option is contingent on a private property regime rather than an open access regime.

[6] De facto because the land was technically owned but the owners were absentee and resident in Santiago. They had never visited the property and exercised no real control over it. This absentee landholding is a relic of the Pinochet dictatorship and not uncommon in southern Chile.

5.1 EMPIRICAL MODEL

The model contains a total of six productive sectors: industry, agriculture (cattle), open-access ranching, tourism, services and retail. The productive sectors are assumed to have Cobb-Douglas production functions which are calibrated from the activity columns in the Social Accounting Matrix (SAM) . The Cobb-Douglas exponents are taken from the literature (Karagiannis, Palivos, and Papageorgiou 2005). The economy contains three factors of production: land, labor, and capital. Intermediate goods used in production are determined from the SAM and modeled as Leontief goods with fixed demand as a percent of output.

There is a government that both taxes and provides subsidies to the region as well as a representative household as the consumer. This household provides labor to the production sectors and consumes both locally produced and imported goods. All production sectors both import and export goods. Output prices are set exogenously. The constrained maximization problem the household faces is the following:

$$\max_{x_i, x_m \geq 0} U(x_i, x_m) \; s.t. \; p_i x_i + p_m x_m \leq \sum_f w_f L_f + h \qquad \textbf{26}$$

The household maximizes utility generated from purchasing imported and local market goods (x_i, x_m), subject to the constraint that the total amount spent on imports is less than the value of their factor endowment as it is divided among productive activities (*f*) plus outside income (*h*). While Palena is not so distant that imports/exports are impossible it is sufficiently distant from other local labor markets to make the total labor supply plausibly fixed. Thus, the model's labor supply is constrained by what is supplied by the representative household. Thus, total labor across all three sectors must equal the labor endowment of the household. We assume that the full endowment of labor is utilized for work; that is, the representative household derives no utility from leisure. Assuming an additive utility function whereby demand for market goods is endogenously determined is given by the following:

$$x_m = \frac{\sum_f w_f L_f + h}{p_m} - \frac{p_i x_i}{p_m} \qquad \textbf{27}$$

Consumption thus depends on household income and exogenous prices. Prices are exogenous because even in the agricultural sector, which primarily consists of ranching, the products are exported. Retail prices are set by the price of imports, which are determined exogenously. Tourism, particularly the brand marketed by Patagonia Sur, is an exported good that is not consumed within Palena. As a result, the quantity of goods consumed and goods produced are not constrained to be equal. The market clearing constraint is that the value of imported goods must equal the value of exported goods. Initial budget shares are determined by the household columns in the SAM.

Each equation is parameterized using values from national survey of Palena (CASEN 2009, BCN 2012) and data from agricultural surveys of Patagonia (Vera 2006).

5.2 DATA

The data used to calibrate the model to the Palena village economy comes from national accounts data from the Central Bank of Chile. This data is reported for each of the eleven regions in Chile and the Los Lagos regional data, of which Palena is a part, was scaled to Palena based on data from the Chilean Library of Congress. Because the national accounts data is only reported at a region level, it was necessary to scale the regional numbers by the number of employees in each industry, or the number of households, in Palena relative to the region as a whole (this data was downloaded from the Chilean Library of Congress (BCN 2012)). This assumes there is a linear relationship between the number of employees and the output of each industry but it does ensure that only the industries present in Palena are represented in the model.

The scaling is based on a population of 1,632 in just under 500 households in the village in 2012 with an average annual income of 427,000 Chilean pesos. That represents 0.2% of the population of the Los Lagos Region of Chile. This was the scaling factor used for household data. 98% of those employed were employed in small or micro enterprises and 18% of the economic activity came from the agricultural sector (surpassed only by 28% in the retail/wholesale sector). Within the agricultural sector 58% of the

activity is in cattle ranching with sheep ranching the next largest sector (BCN 2012). Industry level data (the sales figures for agricultural activities for example) were scaled by the number of industry enterprises in Palena versus the total number enterprises in that industry in the Los Lagos region. This data was supplemented and ground-truthed by data provided in interviews by employees of Patagonia Sur. The interview provided data including the financial information from Patagonia Sur representing tourism activity in Palena that summarized their payments to each of the other industries in the model.

The data is aggregated into a single SAM (Appendix I) that represents the flows of money through the village in 2007. In addition to the five industries (Agriculture, Industry, Tourism, Services and Retail) in the village, the SAM includes flows to and from government and to and from the global (external) economy. In addition to the flows of money through the village the SAM includes payments to the factors of production: land, high skilled labor, low skilled labor and capital. Factors are paid based on the price of the factor in each productive use and income from factors is then distributed to the owners of the factor. In the case of both classes of labor, the household owns 100% of the factors and so receives the full payments from both high and low skilled labor. Ownership of physical capital resides either entirely with the household or, in the case with private land and tourism, with both the household and tourism operator. Ownership of land depends on which scenario is being modeled. In the case of open access ranching, it is assumed the household owns the land but receives no rent payments. This reflects the fact that land rents will be competed away by labor and so all rents will, in effect, be paid to labor. In the case with private ownership of the land and a tourist operation the factor payments from land are paid to the tourist operator, who resides outside of the local economy.

The model is programed in Generalized Algebraic Modeling System (GAMS). Parameterization is based on the observed levels of production across each industry. However, because the tourist operation currently exists it was not possible to observe the open access level of ranching. Thus, the open access ranching parameters are based on communication with ranchers who ran cattle on the land prior to its purchase by Patagonia Sur. It is assumed that the reported ranching intensity represented the steady state

level in the open access case. While total biomass at the open access level is unobserved, the total acres in open access and the stocking rate on this land is observed. That, combined with the growth rate of biomass, and the maximum level of biomass on the land, is sufficient to determine the open access steady-state level of biomass. Returns to labor in the open access case are declining in the short run as the stock of biomass is fixed and ranchers take this as a given rather than a choice variable. If additional land can be added returns to labor would be constant.

5.3 SIMULATION

I run the model under three cases to test the effects of changing the property rights regime. In the first case the land is fully privatized and tourism is the productive use of the land in question. This is the base case and employment, wages, and productivity from the other cases are compared to this case. The second simulation is then run as if the tourism operation did not exist and the land remained in open access. The productive use of the land in this case is always cattle ranching. Labor employed in the tourism operation in the first simulation is reallocated throughout the village economy and wages and production adjust. In this simulation the level of biomass on the land in question declines to reflect differences in the steady state level of biomass between tourism and ranching. These differences come about because of the non-consumptive nature (with regard to biomass) of tourism, which allows the level of biomass to recover to its carrying capacity. The implications of this change are discussed further below.

The third and final case is where the open access land is privatized but the productive use remains ranching, rather than tourism. This is the case discussed by Weitzman/Samuelson.

In all of the simulations the supply of labor remains fixed. This reflects the remoteness of the community. It is also assumed the physical capital remains fixed across uses as there is no endogenous mechanism for investment in capital in the model.

5.4 RESULTS

Table 1 shows the results of the simulated changes from the base case. Although the effects are small they are noticeable. The privatization of open access land for tourism increases low wage incomes by just less than 2% relative to the use of the land for open access ranching. Overall household income increases by 2.24% in the tourism case and exports increase by 3.35%.

These effects are small but notable because they indicate that a shift from open access land to private ownership of the land not only does not reduce labor incomes but can increase them if the shift in property rights regime is accompanied by a change in productive use. Even a small increase confirms the theoretical possibility laid out above that privatization can benefit labor in the economy regardless of the distribution of newly generated rents. This is in contrast to prediction of lower factor wages that occurs when the productive use of the resource remains constant. . The overall increase in exports and household income is expected – privatization leads to an increase in economy wide efficiency – but are notable because this increase in economy-wide efficiency occurs even when the rents leave the local economy (they are paid to the tourist operator). In this case, contrary to Samuelson, the rent collector is "worth of his full hire."

The second simulation, where land is privatized but the productive activity remains the same, demonstrates greater departures from the tourism base case for low skilled labor. In other words, shifting from the open access case to the private ranching case decreases labor incomes in the steady state. This is a confirmation of the result from Weitzman/Samuelson and confirms that the critical feature of the tourism case results is the new productive use of the resource.

Table 1. *Percent change from a change in property rights*

	Rights Regime (Percent changes)	
	Open Access Ranching	*Private Ranching (Weitzman Case)*
Household Income	-2.24	-2.94
Wages		
Low-Skilled Labor	-1.9	-2.49
High-Skilled Labor	0.73	0.06
Capital	0	0
Land (Private)	-24.32	-72.64
Exports	-3.35	-1.32

An important caveat to these results is that they are heavily dependent on the stock recovery effects that result from tourism. Because tourism is a non-extractive use of the biomass on the land the steady-state level of biomass in the tourism case is the carrying capacity of the land. This is not the case in the open access ranching case (or even the private ranching case). In those cases the steady-state biomass level is approximately 50% of the carrying capacity. This number is based on a logarithmic growth function for the biomass (Barlow 1987) and average parameter values for Patagonian grasslands and ranching operations (Vera 2006). While there is no reason to believe it is not an accurate representation of reality it should be noted that the results are heavily dependent on this parameter (See Appendix II for a sensitivity analysis around this parameter). If the open access steady-state level is less than 50% of the carrying

capacity the improvements in labor incomes from shifting to tourism become even larger. Conversely, as the steady-state level of biomass in the open access case approaches 100% of the carrying capacity, the gains from tourism decline.

Comparing the model results to anecdotal evidence from the region confirms the results. While Patagonia Sur has not explicitly measured the change incomes of the community over time they have noted that incomes have generally improved since they began operations. Interviews with former ranchers now employed by Patagonia Sur as guides indicate that their personal incomes have also increased.

6. POLICY IMPLICATIONS & DISCUSSION

The localized general equilibrium approach used here demonstrates that in Palena the privatization of open access ranch land and subsequent creation of an ecotourism destination increased local factor wages. The increase in labor incomes results in an overall increase in household incomes and corresponds to an increase in the total output of the local economy. This is interesting for a few reasons. First, as an empirical confirmation of the fact that the Weitzman/Samuelson model is not the end of the story with regard to the impacts of privatization. In Weitzman's words, it is possible, both in theory and empirically, that the efficiency effect dominates the distributional effects, in contrast to Weitzman's conclusions.

In the context of the debate over conservation methods discussed in the literature review above this result indicates that exclusive reserves could benefit local communities. In particular, the possibility exists for mutually beneficial relationships where an outside owner gains ownership of a resource in return for providing external knowledge of tourist operations that increase local employment opportunities. In the Patagonia Sur case the local labor benefited even though they lost 100% of their access to the previously open access resource. This increase in wages was driven entirely by economic activity made possible by the exclusive reserve nature of the conservation project. These results make it clear that one cannot dismiss exclusive reserves as universally harmful to local incomes or welfare. However, they do not indicate conclusively that an exclusive reserve is better for local incomes than a reserve that provided tourism opportunities and granted them some level of access. Demonstrating that is a possible next step. Doing so requires showing that granting access to locals would decrease the productivity of the tourism operation enough that the decline in labor incomes offset the increase in income coming from access.

While my empirical results demonstrate that the representative household in the model is better off under the tourist case with a closed reserve the structure of the model ignores distributional impacts. In this model all factor payments are received by a single household. In reality it is likely for there to be differentiation in the ownership of factors among households. As a result, a policy which increases

incomes for low skilled labor but not high skilled labor or increase payments to capital but not labor will have a differential impact on household incomes depending on which of the factors they possess. A complete analysis of the transition from open access to private ownership of a resource should include a consideration of these distributional impacts.

A further distributional consideration, unique to this setting, is the existence of the Patagonia Sur Foundation. While not modelled in the base case, the Patagonia Sur Foundation works closely with Patagonia Sur LLC, which by mandate donates 15% of profits to the foundation, to promote community development around Palena. As a result, some of the rents which are generated by the privatization of the open access land in Palena and that are paid to Patagonia Sur are then returned to the community through the foundation. This is not modelled here because questions of the political economy of how resource rents are distributed were deliberately not included in the theoretical model but they are an important consideration in practice. As Weitzman/Samuelson recognized 40 years ago, the increase in rents may be large enough to improve labor incomes depending on how they are redistributed. Combining programs like the Patagonia Sur Foundation with privatization of open access resources can accentuate the income improvements observed here.

Finally, there are two important aspects of the approach taken here to keep in mind when considering these results. The first is the dependence of the impacts on labor wages on the assumption that labor supply is fixed. Because of Palena's remoteness and general lack of economic opportunity this seems a reasonable assumption in this specific case. Population in the village has actually declined over the last fifteen years – a period corresponding to the growth in Patagonia Sur's tourism operations – as younger community members move to the regional economic center at Puerto Montt or the capital, Santiago. Despite this, it is not the case in all tourist destinations that labor supply is fixed or declining. As Taylor et al (2009) point out in the Galapagos, where immigration erased all of the benefits to local labor from increased tourism activity (and in fact had detrimental environmental impacts). Any program looking to

take advantage of the effects described here must carefully consider the labor mobility and likelihood of immigration in their particular setting.

The second consideration is the dependence of this approach on the economic linkages as identified in the SAM. The relative productivity of each sector plays a large role in determining how factors are allocated in the economy and changes from the assumptions made in the SAM could change both demand for factors and, as a result, their wages. Further, there may be barriers to movement of factors from one sector to another. We assume that capital is immobile – the capital needed in a retail operation is likely much different than that needed in a tourist operation – but labor is not. This may not exactly reflect reality. Certain jobs require skillsets that are learned over time. Of particular relevance to these results is the different skill sets needed to be a rancher versus a tourist guide. While some labor may be able to make this transition (as has been the case in Palena), others might struggle. The more difficult it is for labor to transition, or to conduct the necessary training to allow the transition, from one productive sector to another the less beneficial the transition in productive use will be.

In light of these concerns the results here should be taken primarily as a confirmation of the theoretical results laid out above. While it seems clear that the transition to tourism has benefited Palena this model does not conclusively demonstrate the magnitude of those benefits. Nor does it indicate that similar privatization exercises in other communities will have the same size benefits. Rather, it confirms empirically that privatization of an open access resource can improve labor incomes, regardless of the distribution of rents, if that privatization leads to a transition in productive use.

7. CONCLUSION

In this paper we demonstrate that the canonical Weitzman/Samuelson result that privatization leads to lower labor wages relative to an open access scenario does not hold in all cases. Specifically, I've shown that – independent of the distribution of newly created rents – privatization can improve labor wages if that privatization leads to a shift in the productive use of the resource. In other words, although the labor wage remains equivalent to the value of marginal product in the privatized case, if the new use's value of marginal product is larger than the open access use's value of average product, labor wages will improve under privatization. This is important, and we believe unique, because it demonstrates that labor wages can improve in the absence of redistributionist policies or any labor rights to the newly created rents.

It is important to note, however, that these results are not universally true. It is theoretically possible for the new value of marginal product to be less than the old value of average product even when the productive use changes. In that case the Weitzman/Samuelson result will still hold. In the context of open access resources that rely on a stock of biomass the stock effects of privatization play a significant role in determining whether the new VMP is greater than the old VAP. New productive uses which use the stock less intensively are more likely to result in improvements in labor wages.

In addition to demonstrating theoretically and with an empirical example that labor wages could improve, we show that there exist conditions under which, despite the potential improvement, communities would not organize on their own to realize the higher wages. This is important because it makes a case for the need, at least in some cases, for privatization rather than community organization to realize the benefits. It is particularly likely that privatization will be necessary in cases where reaching the new productive use requires substantial investment or new knowledge. In any case where the open access productive use would actively degrade the new, more productive, use privatization is also likely to be necessary.

One context in which these results may be particularly useful is in the development of conservation reserves. These results demonstrate that it is possible for a conservation reserve to benefit a local

community even if that community loses their traditional level of access to the resource. If the new reserve is used to generate tourism this could provide sufficient employment opportunities for the local community to offset the lost income from an open access resource property regime. It should be highlighted, however, that this will not be true in all cases. The empirical example here relies heavily on high-end tourists willing to pay a premium and the fact that labor immigration is non-existent. Whether the results hold elsewhere depends on conditions in those localities.

In general these results highlight the importance of considering the wider impacts of property rights regimes when analyzing the effects of changing them. Property rights regimes may have a direct impact on the way in which a resource is utilized, not only on the level at which it is utilized. As a result, changing the property rights regime will change the level at which a resource is used but it may also change the use itself. This means that the full effects of a property rights change cannot be captured by simply moving from the VMP to the VAP curve. Rather it suggests that a local general equilibrium approach which measures the effects of a shift in the productive makeup of the local economy will more accurately capture the full effects of the property rights change.

Going forward possible extensions include an examination of these effects in locations where the new productive use is something other than tourism. A more explicit bio economic examination of the role that stock rates play would also be informative. Finally, examining these effects in a dynamic model – rather than one based on steady state levels – would reveal effects on labor during the transition period between open access and privatized uses.

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APPENDIX I: PALENA SAM

In Millions of Chilean Pesos

	Ag	Indust	Tourism	Services	Retail	Government	Household	Laborlow	Laborhigh	Physcap	OAland	Land	External	Total
Ag	78.07	64.08		1.51	3.00	0.48	35.22						203.06	385.44
Indust	67.43	90.17		204.86	49.45	15.95	345.94						749.68	1523.49
Tourism													157.26	157.26
Services	133.74	179.07	14.85	477.82	120.83	41.03	1407.56						420.88	2795.79
Retail	28.35	27.79		135.29	41.17	6.75	436.29						147.85	823.50
Government	21.01	68.75	7.96	113.60	39.55	330.34	246.58						8.87	836.66
Household						61.90		1061.21	471.66	855.94		20.89		2471.59
Laborlow	35.95		42.18	955.67	27.41									1061.21
Laborhigh		48.90		43.30		379.46								471.66
Physcap		96.59	34.77	620.33	134.68	0.74								887.11
OAland			16.48											16.48
Land	20.89													20.89
External		948.13	41.01	243.40	407.40					31.17	16.48			1687.60
Total	385.44	1523.49	157.26	2795.79	823.50	836.66	2471.59	1061.21	471.66	887.11	16.48	20.89	1687.60	

APPENDIX II: BIOMASS SENSITIVITY ANALYSIS

Table 2. *Sensitivity Analysis*

	Level of biomass relative to carrying capacity in the Open Access Case		
	25% of CC	*50% of CC*	*75% of CC*
Household Income	-2.33	-2.24	-2.22
Wages			
Low-Skilled Labor	-2.19	-1.9	-1.85
High-Skilled Labor	0.87	0.73	0.73
Capital	0	0	0
Land	-23.94	-24.32	-24.39
Open Access Land	0	0	0
Exports	-3.59	-3.35	-3.38