Increasing demand for Avocadoes is harming the environment in Michoacán, Mexico

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1 Introduction

Avocados have been touted as a superfood, and the trend has been driving its popularity in recent years leading to a rapid increase in consumers' demand. [3] Mexico is currently by far the largest producers for avocados, and in specific the state Michoacán accounts for 80% of Mexico's total avocado production. Most of the existing demand is from the US, and Michoacán is the only state currently holding access to export to the US market.[6] This demand is further fuelled by the improved trade relations between China and Mexico, where the tariffs had fallen from 25% to 7% within the past 2 years[4], improving the price competitiveness of goods from Mexico. Accompanied by an avocado marketing campaign conducted by the federal marketing agency ProMexico Foreign Affairs department [5], export avocado sales to China in the first half of 2018 were 7.1% more than the entire 2017.[5] Making it an extremely lucrative industry for the people in Michoacán.

2 Problem

The forest is a relatively open access resource that many people such as those in the forestry industry are dependent on. Despite having laws in place, weak monitoring has rendered it ineffective and illegal stealth planting of avocado seedlings and subsequently logging of other trees have continued to occur (Stealth practices), causing huge losses in biodiversity. [2] This is a case of the tragedy of open access as farmers aim to maximize short-term profits and exploit the forest to the fullest extent without considering the future of the forest. It also generates huge negative externalities as it negatively affects third parties such as people depending on the forest or its resources, who are uncompensated. For example, people in the forestry industry for timber or people that value the intrinsic beauty of the biodiversity. In addition, the use of a large number of pesticides and herbicides to boost production in both the illegal and legal avocado farming has resulted in polluted groundwater affecting locals that use these sources of water. It has been suspected that there might be a correlation between rates of anencephaly and leukemia [10], and the high amounts of chemical residue

in these major avocado zones. To worsen things, avocados have a high global average water footprint of $1981 m^3 per ton$. [7] This may cause a serious water depletion in Michoacán.[8] All the above shows the amount of negative externalities generated from producing avocados. While the private marginal benefits increasing over time due to demand from the US and China results in avocados being increasingly over-produced and increasing the deadweight loss to society. (Figure 1)

3 Regulation and Evaluation

The main policy in place to tackle the issue of the rapidly decreasing biodiversity is through a voluntary system called the Payment for Ecological Services (PES). It is where the government would pay the farmers to not use their land if the land is found to have direct measurable benefits. However, the increasing opportunity cost of conserving the land has been increasing as international demand for avocados grow to the point where it outweighs the benefits they would get from PES. Since it is a voluntary system, farmers would simply opt out. Though there are farmers that are enrolled in the program, some of these farmers continue to conduct stealth practices as monitoring remain lax. In the PES system, stable and reliable financing is of utmost importance so farmers continue to trust the program will sustain and be enrolled in it. However, corruption still remains an issue in Mexico and this lack of trust makes it difficult to ensure stable financing. [2] Currently, the government is the main financing source, though there are some private financing, it remains insufficient. As seen in 2017, the budget for the PES program was cut by almost 90%. (This is a Nash Equilibrium illustrated in APPENDIX B Fig 2, 2.1) Thus, it is important for the government to have diverse methods of financing such as through taxes, loans, and agreements with private investors and international help. However, in order to do so, the government needs decrease corruption and build up trust between them, the investors and farmers.

There are also conflicting goals between agriculture and environmental policies. Under the status quo, farmers and the economy would benefit greatly as avocados have been generating significant economic benefits. Exports increased 831% between 2013-2017, valued at US $25 Million in 2018. Thus, making it difficult for environmental policies to push through given the high opportunity cost of conserving land and strong resistance from other agencies and farmers benefiting from it. Furthermore, conservation in one location, that is deemed to have measurable benefits, may lead to deforestation in other places instead. Thereby, undermining the effectiveness of the program.

This "Polluter is paid" ideology of the PES system creates little incentive for farmers to innovate to improve productivity the of avocados through more sustainable methods, crowding out any existing altruistic motivations [11] and making it less likely for them to conserve once the benefit from PES is less than benefits from exporting avocados.

4 Conclusion

An alternative proposal would be to shift towards a compulsory system, but problems of financing remain, the payments must still reflect the opportunity cost, and there must be strict monitoring to ensure compliance which can be too costly for a developing country like Mexico. Similarly, with a results-based program under REDD+[2][9] corruption would be a strong hindrance, and ability to quantify results has been proven to be difficult. [2]

Perhaps innovations in sustaining production through less harmful ways might be the best long-term solution. However, this has low returns in the short run and may be costly to be undertaken by a developing country like Mexico. More international support is required not just through financial incentives but also to decrease corruption in the country and education on sustainable farming.

Furthermore, I have evaluated the program through the use of game theory and behavioural economics to determine the two targets to induce cooperation between government and farmers (APPENDIX B 2.1). Aside from the increasing punishment and methods mentioned above, a possible insight could be to encourage altruism, sense of fairness (to increase utility from Cooperating) and guilt (Decrease the payoff from Cheating), possibly through education, thereby inducing cooperation. (APPENDIX B Fig 2.0, 2.1, 2.2)
989 Words

A Illustration of Negative externalities

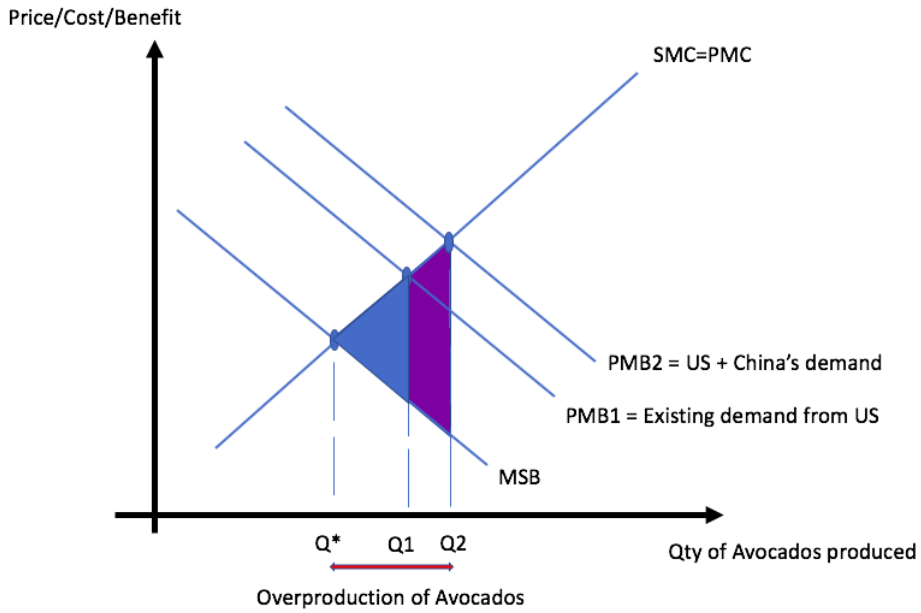

Fig 1: Market for Avocados in Michoacán, Mexico. Existing demand from US (PMB1) have already resulted in a deadweight loss (Blue triangle) Overproduction of Q1Q* amount. Additional demand from China results in further overproduction and a larger deadweight loss of (Blue+Purple triangle).

B Evaluation of Regulation using Game Theory

*Disclaimer: This is my personal thought process while evaluating the regulation, showing through Game Theory the reason for the situation happening right now and intermediate step needed to encourage the Socially optimal outcome.

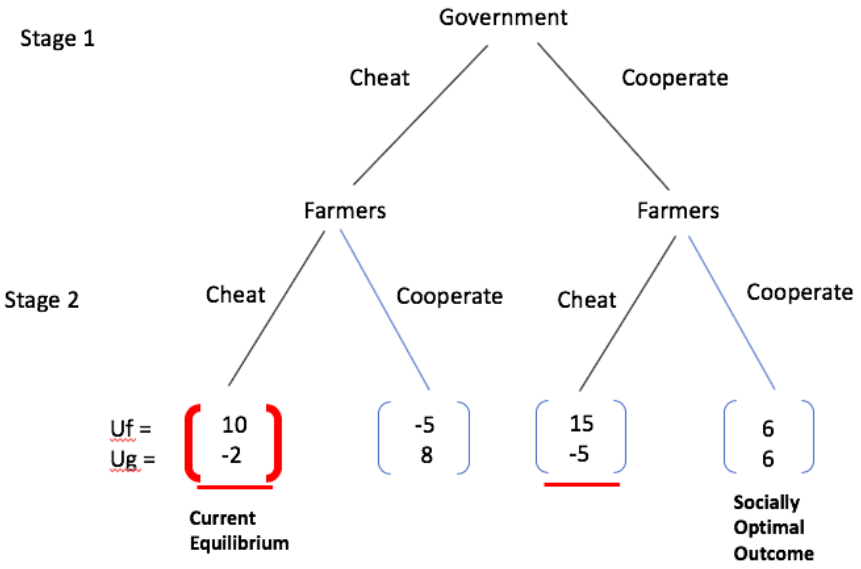

Figure 2.0: Sequential Game Theory depiction of the problem in regulation. [Numbers are deduced personally based on logical assumptions derived from the situation, numbers are not meant to be literal but as a form of values relative to each other]

Definition of Cheating and Cooperation:

- Cheat (**Government**): Failed funding/Not giving out the PES incentive
- Coop (**Government**): Giving the incentives
- Cheat (Farmers): Continued to illegally farm Avocados
- Coop (Farmers): Not illegally farming Avocados, Conserving the land

Definition of utility:

- **Government's utility** takes into consideration of whether or not they met their goal and environmental damage
- **Farmer's utility** is solely based on monetary gains
- **Society's outcome** in my simplified diagram is based on summing both as we assume government's utility took into account the negative externality

(APPENDIX B 2.1)
Through backward induction, Farmer's dominant strategy is to cheat, and thus Government's best response is to cheat. –> In line with what Is currently happening in Michoacán –> and Farmers continue to illegally farm Avocados ("Cheat") and the Government cut budget ("Cheat")

(APPENDIX B 2.2)
In order to induce (Coop, Coop), you would have to make the
1. Punishment large enough (accompanied with monitoring) would lead to a fall in Expected Utility of Cheating to deter "Cheating"
2. Payoff from "Cooperating"> "Cheating"

In order to facilitate the 2nd scenario, it is possible through behavioural economics where the government could find ways to encourage altruism, sense of fairness (to increase utility derived from Cooperating) or induce guilt (Decrease the payoff from Cheating) thereby inducing cooperation.

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