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Article

How the Tourism Industry Can Help Resolve Mongolia's Environmental Problems

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Abstract: In this paper, we use a theoretical model to show that the development of the tourism industry is very likely to significantly reduce environmental problems in Mongolia. Among other issues, Mongolia suffers from an excessively large livestock population, which causes considerable environmental damage. In particular, the excessive livestock population leads to the desertification of the Mongolian steppe, and the emissions of methane and nitrogen dioxide caused by the livestock contribute significantly to Mongolia's greenhouse gas emissions. Our approach essentially relies on creating jobs in the growing tourism industry for those employed in agriculture, using appropriate economic tools. The consequences of such a change include decreasing environmental damages. Particularly, we analyze three policy measures, environmental taxes, lump-sum contributions of hotels to finance advertising, and a tax on profits, to finance advertising expenditures. To support our theoretical results, we show, using available data that it is very plausible to conclude that the GHG emissions caused by additional tourism are far less than the GHG emissions likely to be saved by our economic policy recommendations. This paper shall help economists and interested policymakers to understand how the development of tourism can reduce environmental damages.

Keywords: tourism industry; Mongolia; greenhouse gas emissions; desertification; tourism economics theory; tourism policy



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1. Introduction

Tourism as a means to mitigate environmental damage and greenhouse gas (GHG) emissions is a topic of growing interest. Through a case study on Mongolia, this paper aims to demonstrate how promoting tourism can reduce environmental impact and GHG emissions. By focusing on the excessive livestock population in Mongolia contributing to desertification and methane emissions, we will explore the potential of tourism to foster sustainable development. Therefore, it is the aim of this paper is to show that tourism can reduce environmental damage and greenhouse gas (GHG) emissions. Mongolia suffers from an excessive quantity of livestock, which causes the desertification of vast areas of the country. Additionally, the large number of livestock emits a significant amount of methane (CH₄), a highly potent greenhouse gas. Conversely, Mongolia has a small but rapidly growing tourism industry. This paper's primary goal is to show that promoting the tourism industry through appropriate policy measures will expand the tourism sector, reduce the agricultural sector, and consequently decrease the number of livestock.

Our theoretical approach is based on the work of [Stauvermann and Kumar \(2017a, 2017b\)](#), who developed a model of monopolistic competition in the hospitality industry. This model is extended by integrating the agricultural sector. The second aim of this paper is to highlight a possible mechanism through which increasing tourism—despite being associated with significant emissions ([Gössling, 2013](#)) mainly from transportation ([Gössling & Humpe, 2020](#))—may reduce a country's total emissions. Several empirical studies (e.g., [Lee & Brahmašreṇe, 2013](#); [Azam et al., 2018](#); [Alam & Paramati, 2017](#)) have concluded that tourism reduces CO₂ emissions. However, these empirical studies do not provide a plausible argument explaining how this reduction occurs, as tourism is associated with significant emissions of GHGs. This is to some extent dissatisfying, because the mere presence of a statistical relationship without theoretical or intuitive reasoning is not convincing. Therefore, one motivation of this paper is to fill this gap and present a theoretical foundation for how tourism can contribute to the reduction of GHG emissions. As our study shows, it is possible for tourism to reduce emissions if the tourism industry displaces existing industries that are less eco-efficient. Therefore, whether tourism reduces emissions depends on which industries are displaced by tourism. Consequently, it is not surprising that different studies (e.g., [Gössling, 2002](#); [Azam et al., 2018](#); [Paramati et al., 2016](#); [Paramati et al., 2017](#)) investigating the environmental consequences of tourism come to contradictory results, because the impact depends on which other industry shrinks or is displaced as a result of growing tourism.

In general, it can be stated that agriculture is the most eco-inefficient industry in terms of greenhouse gas (GHG) emissions per dollar, particularly if it is based mainly on animal husbandry due to the methane (CH₄) and nitrous oxide (N₂O) emissions from livestock. Therefore, if tourism is able to reduce and substitute livestock farming as a source of income, tourism will help to reduce GHG emissions of a country, although it is plausible that with a growth in tourism activities, GHG emissions would increase. In an ideal world, the developing tourism industry would be a form of so-called sustainable tourism, but this is unfortunately often more a desire than reality. However, we argue that even when conventional tourism is taken into account, including flight emissions, a country's greenhouse gas emissions can be reduced.

Thus, in this paper, we first provide a background based on economic and environmental data related to Mongolia (in Section 2). From the facts noted, it becomes clear that every dollar of value added in the tourism industry is associated with much lower emissions than a dollar of value added in the agricultural sector. In Section 3, we will introduce a theoretical model that describes an economy consisting of two industries: tourism and agriculture. In Section 4, we show that the government can shift economic activities from the agricultural sector to the tourism industry through appropriate economic policy measures. In the context of Mongolia, this means it is possible to reduce the agricultural sector and enhance the tourism industry, resulting in lower emissions, reduced soil erosion, and increased income. These findings have important implications for environment.

Noting the lack of scientific studies on tourism in Mongolia, we have merged the key literature that we could find with the section on background (Section 2). The literature studies we present are generally from various international organizations, such as the World Bank, the International Monetary Fund, and Japanese Development Aid. The intention of these reports is either to show ways to reduce the number of livestock and at the same time improve the quality of the final agricultural products (improved wool and meat quality) or simply to improve the efficiency of tourism.

The rest of the paper is organized as follows. In the next section, we present the relevant facts on the environment, economy, and tourism industry in Mongolia. In Section 3, we introduce the economic model; we consider the agricultural sector in Section 3.1, determine

the environmentally sustainable number of goats in Section 3.2, present the demand for tourism in Section 3.3, and introduce the supply side of the tourism industry in detail and determine the market equilibrium of this two-sector economy in Section 3.4. In Section 4, we analyze the model in four subsections with respect to growing demand for tourism, environmental tax on goats, lump-sum contributions of hotels to finance advertising for tourism, and a profit tax on hotels to finance advertising for tourism. In Section 5, we discuss our results and the limitations of the study, and in Section 6 we provide concluding remarks.

2. Environmental and Economic Background of Agriculture and Tourism in Mongolia

In this section, we will calculate and compile some statistical indicators that are important for our purposes. However, the existing data published by the statistical office of Mongolia, the World Bank, the World Travel and Tourism Council, and the UN World Tourism Organization on Mongolia are not coherent and partly contradictory. Nevertheless, it is important for our purposes to demonstrate that the tourism industry is more eco-efficient and more productive than the agricultural sector.

Mongolia, a landlocked country well-known for its vast steppes and nomadic culture, is facing a severe environmental crisis due to desertification (Han et al., 2021; Lamchin et al., 2016; H. L. Zhao et al., 2005; Wang et al., 2024; Sainnemekh et al., 2022; Y. Zhao et al., 2023). Desertification is the process by which fertile land becomes desert. The reasons are typically drought, deforestation, or inappropriate agriculture. In Mongolia, this phenomenon has been exacerbated by a huge increase in livestock over the last 50 years. Shyndaulyet (2023) states that the number of livestock has increased from 22.5 million in 1970 to 67.1 million in 2021. This increase in farm animals has led to significant environmental and socio-economic challenges. According to Shyndaulyet (2023), 76.9% of the land is affected by the strong increase in livestock as well as by climate change leading to land degradation. For example, between 2019–2020, around 2000 surface water sources have dried up, but fewer than 1000 water sources have been restored.

A main reason for these developments is overgrazing and deforestation. Overgrazing by livestock has resulted in the degradation of grasslands, which are essential for maintaining soil stability and preventing erosion. Deforestation, mostly driven by the need for fuelwood and agricultural land, has further decreased vegetation cover, leaving the soil exposed to wind erosion. According to Han et al. (2021), the country has experienced a significant increase in temperature and a decrease in precipitation in recent decades. Between 1940 and 2015, the annual mean air temperature in Mongolia increased by 2.24 °C, while annual precipitation decreased by 7%. The consequences of desertification in Mongolia are manifold. The loss of fertile land has resulted in decrease agricultural productivity, and the frequency of sandstorms has increased. These sandstorms are also negatively impacting the air quality in China, Japan, South Korea and the USA significantly by increasing the concentration of PM₁₀ and PM_{2.5} particles. This so called “Yellow dust” reduces visibility, causes respiratory health issues, and leads to damage to crops and soil due to the industrial pollutants, heavy metals, and other harmful substances it carries in the affected countries.

Lkhagvadorj et al. (2013a, 2013b) conducted a survey on herders’ livelihood, and note that herders are aware of the environmental problems but they do not see an alternative way to earn income. Drawing insights from Brown (2020), Kimura et al. (2022) state that livestock needs to be reduced by 50% to allow grasslands to recover from damage. Similarly, the International Monetary Fund (IMF, 2019) proposes reducing livestock by 50%. Both sources argue that this is necessary not only to return to ecological sustainability but also to increase productivity in the livestock sector.

Another problem related to excessive livestock is that the agricultural sector, where 90% of it is related to livestock farming, is responsible for around 50% of Mongolia's greenhouse gas (GHG) emissions (Kimura et al., 2022). Mongolia's GHG emissions are relatively high, with more than 17 tons per capita per year in 2019 (World Bank, 2024). In other words, Mongolia is responsible for 0.1% of worldwide GHG emissions, while its share of the world population is only 0.0004%. Jones et al. (2023) note that GHG emissions per capita amounted to 31.5 tons and 27 tons per capita in 2019 and 2023, respectively.

According to the World Bank (2024), the contribution of agriculture to GDP was 10% in 2023, and 26% of the labor force is engaged in agriculture. The agricultural sector is responsible for around 51% of the total GHG emissions (Mongolia, 2023), which means the sector emitted a total of 22.39 million tons of GHG gases, and its monetary contribution to GDP was US Dollars (USD) 2.03 billion.

Moreover, the GWP (greenhouse warming potential) value of 21 for methane, as proposed by Intergovernmental Panel on Climate Change (IPCC) (1995) in 1995, is very low. Considering the targets set in the Paris Agreement, a credible GWP of 80 would be adequate (e.g., Howarth, 2024) because of the shorter time horizon of 20 years. If the latter GWP₂₀ value is used, the emissions from agriculture would amount to nearly 70 million tons of GHGs.

Nevertheless, based on the low GWP₁₀₀ of 21, the agricultural sector emits 11 kg of GHG gases per USD. The national average value of Mongolia's eco-efficiency (kg GHG/USD) is 2 kg per USD. Around 312,000 people work in the agricultural sector, but the distribution of livestock is very unequal. The median herder family's livestock amounts to 91 animals, while the richest 1% of families own about 1835 animals (IMF, 2019). The weighted average GHG emissions per livestock per year is 369 kg (based on author estimation). However, if the number of livestock were reduced by 50%, we could expect a decrease of 11 million tons of GHG per year, which will also result in about USD 1 billion loss in value added and 156,000 jobs. From these estimations, the value added per herder would be around USD 6500.

As noted earlier, the aim of this study is to show that the promotion of tourism will reduce environmental damages, particularly by reducing GHG emissions. Unfortunately, there is no data available that presents the GHG emissions of tourists or tourism industry. Gössling et al. (2005) state that 60~95% of the GHG emissions generated by tourism are caused by transport, with flights being the biggest contributors to transport-related emissions. The case studies presented by Gössling et al. (2005) and Perch-Nielsen et al. (2010) confirm that a detailed estimation of GHG emissions and expenditures of tourists is very complex, time-consuming, and sometimes not satisfactory. The problems associated with calculating environmental-economic indicators for tourists stem from the incompatibility of economic and environmental data on tourism, and in many respects suffers from a problem of missing data. A convincing example of how to account for the economic side of tourism is provided by Van de Steeg (2009), who constructed a tourism satellite account for Aruba. Hence, a compatible environmental satellite account could also be constructed, but it is mandatory to have access to all data from the statistical office.

To address issues related to data and develop a meaningful analysis, we have to estimate these emissions based on a simple and pragmatic approach. Hence, in this study, we present an estimate of the associated GHG emissions by assuming that the average tourist emits as much as a domestic citizen, plus the emissions caused by the flights to visit Mongolia. Usually, the emissions caused by international flights are not considered in the analysis, although they are probably the most important contributor to the GHG emissions of international tourism. The simple reason is that international flights are not represented in the national environmental accounts of any country. To calculate these emissions, we

have used the data collected by Shimizu (2021) and GHG emissions of flights derived from Atmosfair's GHG calculator (<https://www.atmosfair.de/en/offset/flight/> (accessed on 24 February 2025)). The method used by Atmosfair gGmbH (2021) meets scientific standards and calculations can be replicated. In Table 1, we have taken into consideration the emissions of the average airplane type used on the following flight connections:

Table 1. Emissions from flights.

From	To	GHG Emissions per Passenger in Ton	Number of Passengers	Total GHG Emissions in Tons
Ulaanbaatar	Seoul	0.393	3,877,440	428,065
Ulaanbaatar	Tokyo	0.528	79,118	127,064
Ulaanbaatar	Beijing	0.295	214,428	143,667
Ulaanbaatar	Hongkong	0.5041	88,664	135,833
Ulaanbaatar	Istanbul	1.741	41,380	144,085
Ulaanbaatar	Frankfurt	1.978	27,000	106,812
Ulaanbaatar	Irkutsk	0.628	14,239	5098
Ulaanbaatar	Busan	0.423	64,637	81,184
Ulaanbaatar	Krasnoyarsk	1.045	106,703	223,009
		Sum:	1,023,999	1,394,817

Source: Own calculations based on Atmosfair calculator and Shimizu (2021).

Table 2 covers 86% of all international flight passengers who visited Mongolia in 2019. The total quantity of GHG emissions amounted to 1.39 million tons. Due to the differences in GHG emissions of tourist departing from different countries, we calculate the average GHG emissions per capita of the various nationalities. In general, the consumption pattern and therefore the emission pattern of tourists may deviate drastically from that of nationals, as was noted by Rose (1966), McDonald et al. (2009), Gössling (2001), or Charara et al. (2010), or Tourism Concern (2012). Nevertheless, we assume that is not the case regarding tourism in Mongolia, and therefore we assume that tourists behave similarly to Mongolians regarding GHG emissions and calculate the GHG emissions per capita and per day of stay as 0.058 tons. According to Shimizu (2021), 70% of tourists visited Mongolia in the season from April to September, where the temperatures range between 18 to 32 degrees Celsius, so that tourists do not significantly contribute to emissions caused by heating systems. Further, tourists are not responsible for methane emissions caused in agriculture. Additionally, most tourists are in the age group between 24 to 39 years (Shimizu, 2021), generally an age group where people typically have a restricted travel budget. The majority of tourists spend their time with nature and wildlife tours, cultural tours, visits of national parks, Gobi Desert adventures, horseback riding, and camel riding. Regarding these activities, the tourists live mostly in one of the 450 ger camps together with Mongolians. Mongolia has 430 hotels, but only eight 5-stars hotels and 23 4-stars hotels, and only one 4-star hotel is located outside Ulaanbaatar, in Uvurkhangai aimag. This implies that there is nearly no high-end tourism in Mongolia. Therefore, we think that the simplifying assumption that tourists emit GHG as much as nationals is justified.

Table 2. GHG emissions of tourists.

Country	Country	Av. Days of Stay	GHG Emissions of Stay	Flight Emission GHG Tons	Expenditure in Mongolia in USD (2019)	Total GHG Tons Emissions per Tourist	GHG kg per USD
China	168,258	8	8	1.14	1850	1.51	0.91
Russia	141,927	16	16	0.76	820	1.50	1.49
S. Korea	101,279	11	11	0.59	1223	1.10	1.31
Japan	24,419	7	7	1.28	1070	1.60	1.57
Europe	27,194	12	12	1.6	1250	2.16	1.83

Source: Own calculations, based on Shimizu (2021).

Of course, this is just an estimate and we may overestimate or underestimate the quantity, but the outcome coincides closely to the outcome of tourism at the global average calculated recently by Sun et al. (2024).

Using the numbers from Table 2 to calculate the total GHG emissions of tourism, we find that Mongolia's international tourism is responsible for the emissions of 1.55 million tons of GHG gases. Based on the expenditures derived from interviews (Shimizu, 2021), the value added by tourists amounted to USD 1.38 billion in 2019, which exceeds the estimations (USD 707 million) of the World Travel and Tourism Council (WTTC) by around 100%. According to the World Bank, international receipts summed up to USD 605 million. It is, of course, possible that the interviewed tourists made incorrect estimations regarding their own spending, but it is also possible that they spent money on a number of goods and services not officially accounted for. Therefore, the calculations and estimations made must be taken with some caution.

Now, calculating the eco-efficiency (GHG emissions in kg/USD) of tourism from the quantities calculated above, we obtain a value of 1.21 kg/USD. As indicated above, the latter value is very close to the 1.35 kg GHG/USD, which is calculated by Sun et al. (2024) as the global level of GHG emissions per USD value added of tourism. If we take the numbers for value added provided by WTTC and the World Bank, we obtain 2.37 kg/USD and 2.76 kg/USD, respectively.

However, for our purposes, it does not matter so much which value is taken; the most important point is that the eco-efficiency of the tourism industry is much better than that of the agricultural sector, with 11 kg/USD. This is an important result because our model proposes that jobs in agriculture should be substituted by jobs in the tourism industry. The current number of jobs in the tourism industry in Mongolia is also not well documented. For instances, the World Bank (2021) states there were 105,488 jobs in the tourism industry in 2019, the WTTC assumes 88,000 jobs, and the World Tourism Organization around 60,000 jobs. These numbers reflect the difficulty in making useful statements about the tourism industry. However, considering tourism's total value added of around USD 1 billion (international and national tourism) stated by WTTC (2024) serious, then the value added per capita ranged between USD 9523 and USD 16,666 per capita in 2019. Both values significantly exceed the value per capita in the agricultural sector (USD 6500). According to our calculations, a job in agriculture is associated with a value added per person of USD 6500 and around 71.5 tons of GHG (using GWP100 of 1995), while a person working in the tourism industry is associated with a value added of USD 16,600 and around 45 tons of GHG. Even if we assume that the value added in agriculture is underestimated and GHG emissions are overestimated, and the opposite regarding the

tourism industry, it is obvious that substituting a job in agriculture with a job in the tourism industry will lead to an increase in value added and a reduction in GHG emissions.

As noted earlier, reducing the number of livestock by around 50% is associated with a loss of around 156,000 jobs. If the tourism industry is to substitute all these jobs, it is necessary for it to grow by a factor of 2.5 to 3, which is achievable considering that Mongolia experienced a 49% growth of visitors between 2015–2019 (World Bank, 2021). When considering similar countries like Kazakhstan, the Kyrgyz Republic, or Tajikistan, these countries have a much higher number of visitor arrivals and a much higher ratio of arrivals per capita. The arrivals per capita in Mongolia is only 0.2, while it is 0.5 in Kazakhstan and 1.3 in the Kyrgyz Republic (World Bank, 2021).

3. A Stylized Model of Tourism and Agriculture

In this section, we introduce the economic model, which is based on standard economic assumptions. The model encompasses two economic sectors on the supply side: agriculture and tourism, and on the demand side, the demand of international tourists. In Section 3.1, we model the agricultural sector; in Section 3.2, we determine the optimal number of farm animals; in Section 3.3, we model the demand side; and in Section 3.4 and its subsections, we model the tourism supply and determine the market equilibrium.

3.1. Agricultural Sector

Mongolia's agricultural sector is characterized by herders who move around the Mongolian steppe to feed their animals (horses, camels, yaks, sheep, and goats). The majority of the animals are goats used to produce cashmere wool, and therefore we assume all animals of herders focus on goats. Let us assume that each header is using a Cobb–Douglas production function depending on the number of goats and availability of biomass S . Then, the production of cashmere wool q_w per herder can be described by:

$$q_w = D(S)g^\gamma \quad (1)$$

where $D(S) \geq 0$, $D'(S) \geq 0$ and $0 < \gamma < 1$. It should be noted that the biomass is not constant and depends on the climate, weather conditions, and the number of goats and wild animals consuming grass, which were grazed on the land in earlier years. If $D(S)$ becomes too small because of excessive grass consumption in the recent past, the problem is that goats cannot consume enough feed to survive cold winters. This happened, for example, in the years 1998–2003 and 2010 and millions of goats and other farm animals starved and froze to death (IMF, 2019); it was estimated that during this period, 20% of the farm animals died. Without any government intervention, the herder determines her profit according to:

$$\pi_g = p_w q_w - c_w g = p_w D(S) g^\gamma - c_w g \quad (2)$$

where we assume that the unit costs per goat c_w , the veterinary cost and the cost for shearing, and that the world market price of cashmere wool p_w are exogenously given. Further, we assume that $p_w > c_w$. The resulting first order condition is:

$$\gamma p_w D(S) g^{\gamma-1} - c_w = 0 \quad (3)$$

Solving for the number of goat's leads to:

$$g^* = \left(\frac{\gamma p_w D(S)}{c_w} \right)^{\frac{1}{1-\gamma}} \quad (4)$$

This means the number of goats is positively influenced by the price for wool and available biomass in the steppe, and negatively affected by the unit costs. Accordingly, the total number of goats becomes:

$$G^* = L_g g^* \quad (5)$$

where L_g represents the number of herders. The profit per herder is given by:

$$\pi_g^* = p_w D(S)(g^*)^\gamma - c_w g^* = \left(\frac{p_w D(s)}{c_w^\gamma} \right)^{\frac{1}{1-\gamma}} (\gamma^{\frac{\gamma}{1-\gamma}} - \gamma^{\frac{1}{1-\gamma}}) > 0, \quad (6)$$

The profit per herder also represents the income of a herder. Unfortunately, the biomass is rapidly declining in the steppe since the breakdown of the Soviet Union. In addition to the extremely increased number of farm animals, it must be noted that the impact of climate change on the average temperature in Mongolia is much stronger than on the world average (IMF, 2019); the yearly average temperature increase in Mongolia is 0.019 degree Celsius since 1940. According to Meng et al. (2021), 90% of Mongolia is at risk of desertification. Therefore, it is important to restore the steppe to a sustainable track. Hence, in the next subsection we will determine the optimal number of goats in the model.

3.2. The Sustainable Number of Goats

One main environmental issue in Mongolia is that the current number of goats far exceeds the sustainable number. This leads to overgrazing and desertification of the Mongolian steppe. Here, we introduce a simple model to determine how to achieve a sustainable state for the Mongolian steppe. For this purpose, we reduce the model to the main important characteristics that must be considered regarding the overgrazing problem. Let us assume that biomass develops as follows:

$$S_{t+1} - S_t = \Delta S_t = v S_t \left(1 - \frac{S_t}{S_{max}} \right) - s G_t, \quad (7)$$

where S_t represents the biomass in period t , v is the natural rate of grassland's growth, s is the average quantity of biomass consumed by a goat, and G_t is the total stock of goats roaming on the grasslands in period t . It should be noted that v and s , in reality, are not constant and they depend on climate, air pollution, wild living animals consuming grass, and other factors. Regarding the interpretation of the difference equation, the first term on the RHS represents the regeneration of grassland and the second term on the RHS of the difference equation the depletion of grassland. If $S_t < S_{max}$, the grassland regenerates, given that the second term of the RHS is sufficiently small. If $S_t = S_{max}$ the grassland system has reached the carrying capacity, and if $S_t \geq S_{max}$ the first term on the RHS will become zero because of biological reasons.¹

To keep the steppe ecological intact, at first, we must determine the optimal number of goats given the state of the grasslands. For this purpose, we set ΔS_t equal to zero, and solve for G_t . This delivers:

$$G_t^c = \frac{v S_t (S_{mas} - S_t)}{s S_{mas}}, \quad (8)$$

The superscript c indicates that this stock of goats will ensure the state of the grasslands is constant. If the quality of grasslands improves, what will be desirable (in reality) given the current state of the steppe is that the actual stock of goats has to be less than G_t^c . Obviously in reality, the ecologically determined number of goats is less than the profit maximizing number of goats ($G_t^c < G^*$), which is determined without considering the state of the steppe.

To determine the economically optimal and sustainable state of the grasslands and biomass, we maximize G_t^c with respect to S . This delivers:

$$S^{opt} = \frac{S_{mas}}{2} \tag{9}$$

Inserting S^{opt} in G_t^c leads to the sustainable stock of goats:

$$G^{sus} = \frac{vS_{mas}}{4s} \tag{10}$$

Therefore, it is recommended that the government should as first step take all necessary measures to reach S^{opt} , and as a second step it should limit the stock of goats to G^{sus} . This does not mean that the current state of grassland allows a stock of the size G^{sus} . At first, it has to be guaranteed that $S_t = S^{opt}$, and then the goats' stock has to be adjusted according to the difference equation. Otherwise, if $S_t < S^{opt}$ and $G_t = G^{sus}$, the state of grassland may decline.

If we assume that a sustainable state has reached, we know from above that $S_t = S^{opt}$ and $G_t = G^{sus} < G^*$. Thus, the aggregate production becomes:

$$q_w^{sus} = D(S^{opt})\left(\frac{G^{sus}}{L_g}\right)^\gamma < q_w^* \tag{11}$$

Unfortunately, the current profit exceeds the sustainable profit. On the other hand, it should be clear that the sum of discounted sustainable profits exceeds the discounted profits, which will be realized without government intervention. One obvious way to tackle the problem is to introduce a permit system. An important question is how to distribute the fixed number of permits for goats. One way is to distribute the permits equally for free, hence the income of a herder will become:

$$\pi_g^{sus} = p_w D(S^{opt})\left(\frac{G^{sus}}{L_g}\right)^\gamma - c_w\left(\frac{G^{sus}}{L_g}\right) \tag{12}$$

The question which results from this result is that if this income is sufficient to survive. Another approach would be to offer a compensation to herders to change their profession. This means that the number of goats per herder can increase. However, focusing only on these measures will cause a strong hardship for herders. Therefore, we will develop a smarter solution below.

3.3. The Demand Side for Tourism

Here we follow the approach of [Stauvermann and Kumar \(2017a, 2017b\)](#) to model the demand of a composite tourism good. The quantity demanded $X^{T,D}$ is given by:

$$X_T^D = \kappa \frac{Y_f^\epsilon}{p_T^\eta} \tag{13}$$

where Y_f is the aggregate nominal income of tourists denominated in currency of the tourism destination. The variable p_T is the price of the composite tourism good in domestic currency, and the variable $\kappa > 0$ is a constant shift parameter, which may be dependent on advertising for the destination, accessibility of the destination, and other exogenous factors. The two exponents ϵ and η represent the income elasticity of demand and the price elasticity of demand, respectively. There is a vast literature estimating the price and income elasticity of tourism demand. In their surveys on price and income elasticity of tourism demand, [Crouch \(1992\)](#) cited 44 publications on this issue between 1960 and 1990.

Song et al. (2010) surveyed 12 papers between 2000 and 2009, and Nguyen (2021) noted 13 studies between 2010 and 2020. While most studies conclude that the income elasticity exceeds 1, the outcomes regarding the price elasticities range from very low values close to 0 (Vanegas & Croes, 2000; Song et al., 2010; Greenidge, 2001) to two-digit numbers (Lim, 2004). Therefore, we assume that $\varepsilon \geq 1$ and $\eta > 0$. Intuitively, an income elasticity greater than 1 can be explained by the effect that vacation in foreign countries becomes affordable for an increasing number of people. However, the good news is that an elasticity greater than 1 implies a growing tourism market for destination countries as long as the GDP in the respective countries is growing.

Unfortunately, to best of our knowledge, there does not exist any study estimating the price or income elasticity of tourism demand in Mongolia, except for the discussion paper by Bayarsaikhan et al. (2018), which use the gravity model for empirical research. They estimate that the elasticity of tourism revenue with respect to the price has a value of 1.7, which implies a price inelastic demand, and estimate an income elasticity of 1.02. However, we are skeptical of this approach, because the gravity model itself has a very weak economic foundation. This is because, while the gravity model has explanatory power with respect to the trade volume between countries, its usefulness with respect to tourism flows is questionable.

3.4. The Supply Side of Tourism

3.4.1. The Supply of the Composite Tourism Good

According to D'Anieri (2018), the tourism supply in Mongolia has two important elements: the hotels or ger (yurt) camps for sleeping and meals, and drivers and guides. In other words, tourists in Mongolia use a car/small bus and a guide to visit tourism sites of interest. Depending on the distance, they sleep in hotels located in Ulaanbaatar or in ger camps in the countryside. The driver is usually necessary due to poor road conditions and challenging off-road terrain, while the guide is essential to navigate orientation issues, language barriers, and to provide background knowledge on history and culture. Guides also assist with specific tourist activities such as horse riding, climbing, and more. Additionally, guides are useful for teaching inexperienced tourist's activities like horse riding.

Therefore, the majority of tourists buy tour packages from local or foreign tourist agencies or tour operators. A tour package can be interpreted as a composite tourism good. Here, we assume that the quantity of this composite good is produced in the following way:

$$X_T^S = (\sum_{i=1}^m H_i^\beta) L_s^\alpha P^\delta \quad (14)$$

where H_i is quantity of hotel services offered by hotel or ger camp i , L_s is representing the services offered by guides and drivers, and P is representing public infrastructure in a very broad sense. It includes airports, roads, bridges, mobile phone accessibility, internet accessibility, and so on. Regarding exponent β and δ , we assume, $0 < \alpha + \beta$, $\delta < 1$. The variable m represents the number of hotels and ger camps. Further, we assume that the market of tour agencies, who are selling the composite tourism good, is perfectly competitive, so that the agencies are price takers.

Further, the tourist agencies compile the final good by maximizing its profit Π_T :

$$\max_{H_i, L_s} \Pi_T = \max_{H_i, L_s} p_T X_T - \sum_{i=1}^m p_{H,i} H_i - w_s L_s \quad (15)$$

where $p_{H,i}$ is the price of an overnight stay, and w_s is the wage of guides or drivers. Inserting (14) in (15) and differentiating with respect to the hotels and tour guides leads to the following first order conditions:

$$p_T \beta H_i^{\beta-1} L_s^\alpha P^\delta - p_{H,i} = 0, \text{ for } i = 1, \dots, m, \quad (16)$$

$$p_T \alpha \left(\sum_{i=1}^m H_i^\beta \right) L_s^{\alpha-1} P^\delta - w = 0 \quad (17)$$

In an optimum, these $1 + m$ first order conditions must be fulfilled. Equations (16) and (17) can be interpreted as implicit demand functions.

3.4.2. The Supply of Hotels, Drivers and Travel Guides

The tourism industry is characterized by the fact the facilities like hotels are offering services and it is confronted with fixed costs. Particularly, we assume that a hotel i produces its services H_i with the help of the hired workforce $L_{H,i} = H_i$, and additionally the setup of a ger camp or hotel incur fixed costs of $K_{H,i}$ and the respective interest rate is r . Thus, the total costs are given by:

$$C(H_i) = rK_{H,i} + wL_{H,i} \quad (18)$$

Regarding the supply of drivers and tour guides, we assume that the market is perfectly competitive so that the wage rate w of tour guides and drivers is determined by a competitive labor market. We assume for simplicity but without restricting the generality of the results that herders and employees in the tourism industry are perfect substitutes or in other words we assume perfect inter-sectoral labor mobility. Most Mongolians have a basic knowledge about herding and farm animals, because until today a significant part of the population is engaged in agriculture and herding is part of Mongolian culture. On the other hand, a big share of jobs in the tourism industry are related to guiding tourists and driving tourists, both jobs that can be done as long as the person has a good geographical knowledge and a driving license. Both requirements are fulfilled by most herders. Other low-skilled jobs in the tourism industry can also be performed without any problems by herders and their family members. Therefore, the assumption that a job change from one sector to other is possible is to some extent reasonable. However, if the transaction costs to obtain a job in the other sector are not excessively high, our assumptions are also justified.

The hotels are in a market of monopolistic competition and accordingly they take its market demand from (16) $p_{H,i}(H_i)$ and maximize their profits. The profit of hotel i is given by:

$$\Pi_{H,i} = \underbrace{p_T \beta (L_{H,i})^{\beta-1} L_s^\alpha P^\delta L_{H,i}}_{p_{H,i}(H_i)H_i} - wL_{H,i} - rK_{H,i} \quad (19)$$

where the first term on the RHS is the revenue of the hotel. The hotel management maximizes its profit by differentiating (19) with respect to the labor input $L_{H,i}$. The respective first order condition of a profit maximum becomes:

$$p_T \beta^2 (L_{H,i})^{\beta-1} L_s^{1-\beta} P^\delta = \beta p_{H,i} = w \quad (20)$$

Thus, condition (20) requires that the wage rate w , which represents the marginal cost of the hotel equals the price per unit hotel service $p_{H,i}$ times the exponent β . In other words, the price markup over the marginal costs is $\frac{1}{\beta}$. The smaller the β , the more difficult it is to substitute the services of hotel i , and accordingly the higher the price markup.

Now we make the simplifying assumption, that the hotels and ger camps are identical: $H_i = h, \forall i = 1, \dots, m$. We define:

$$L_{H,i} = \frac{L_H}{m}, \forall i = 1, \dots, m \tag{21}$$

And the necessary conditions (17) and (20) become:

$$p_T \alpha m^{1-\beta} (L_H)^\beta L_s^{\alpha-1} P^\delta = w \tag{22}$$

$$p_T \beta^2 m^{1-\beta} (L_H)^{\beta-1} L_s^\alpha P^\delta = w, \tag{23}$$

Assuming that the labor productivity is identical across all workers and herders, it follows that the equilibrium wage $w^* = \pi_g^*$. Using (22) and (23), we can determine the ratio between hotel employees and guides:

$$L_H = \frac{\beta^2}{\alpha} L_s \tag{24}$$

The total labor force in the tourism industry L_T , can be determined by using the identity, $L_T = L_H + L_s$. Using (24) we get:

$$L_H = \frac{\beta^2}{\beta^2 + \alpha} L_T \tag{25}$$

$$L_s = \frac{\alpha}{\beta^2 + \alpha} L_T, \tag{26}$$

Inserting (25) and (26) in (22), and using the fact that a herder's profit equals the wage rate leads to:

$$p_T \alpha m^{1-\beta} \left(\frac{\beta^2}{\beta^2 + \alpha}\right)^\beta \left(\frac{\alpha}{\beta^2 + \alpha}\right)^{\alpha-1} L_T^{\alpha+\beta-1} P^\delta = \pi_g^* \tag{27}$$

Solving this equation for L_T delivers:

$$L_T = m^{\frac{1-\beta}{1-\alpha-\beta}} \left(\frac{\alpha + \beta^2}{\beta^2}\right) \left(\frac{\pi_g^*}{p_T P^\delta}\right)^{\frac{1}{\alpha+\beta-1}} \left(\frac{\alpha}{\beta^2}\right)^{\frac{1-\alpha}{\alpha+\beta-1}} \tag{28}$$

Now we can determine the output of tourism goods by using (25), (26), and (28) and inserting these results in (14):

$$\begin{aligned} X_T^S &= m^{1-\beta} \left(\frac{\beta^2}{\alpha + \beta^2}\right)^\beta \left(\frac{\alpha}{\alpha + \beta^2}\right)^\alpha L_T^{\alpha+\beta} P^\delta \\ &= p_T^{\frac{\alpha+\beta}{1-\alpha-\beta}} m^{\frac{1-\beta}{1-\alpha-\beta}} P^{\frac{\delta}{1-\alpha-\beta}} \left(\frac{\alpha}{\beta^2}\right)^{\frac{\beta}{\alpha+\beta-1}} \left(\pi_g^*\right)^{\frac{\alpha+\beta}{\alpha+\beta-1}} \end{aligned} \tag{29}$$

Because of perfect competition in the tourism good market, inserting the output into the demand function (13) and solving for the price of the tourism good, delivers the equilibrium price for the composite tourism good:

$$p_T^* = \left(\frac{\kappa Y_f^\epsilon}{X_T^S}\right)^{\frac{1}{\eta}} = \left(\frac{P^\delta m^{1-\beta}}{\left(\frac{\alpha}{\beta^2}\right)^\beta \left(\pi_g^*\right)^{\alpha+\beta} \left(\kappa Y_f^\epsilon\right)^{(1-\alpha-\beta)}}\right)^{\frac{-1}{\eta(1-\alpha-\beta)+\alpha+\beta}} \tag{30}$$

3.4.3. The Market Equilibrium

Now, we determine the market equilibrium values, which are indicated by a star, so that all variables are only depending on the exogenous variables' income of tourists, number of ger camps and hotels, public infrastructure, and the demand shift parameter κ . Inserting the equilibrium price from (30) into (28) leads to the equilibrium number of employees in the tourism industry:

$$L_T^* = \left(\frac{\alpha + \beta^2}{\beta^2}\right) \left(\frac{\alpha}{\beta^2}\right)^{\frac{(1-\eta)\alpha + \eta}{(\eta-1)\alpha - (1-\beta)\eta - \beta}} \left(\frac{m^{(\eta-1)(\beta-1)} (P^\delta)^{1-\eta} (\pi_g^*)^\eta}{\kappa Y_f^\epsilon}\right)^{-\frac{1}{\eta(1-\alpha-\beta) + \alpha + \beta}}, \quad (31)$$

Knowing the number of employees in the tourism industry, we can also determine the number of herders. Let the total labor force be L . Then, the equilibrium number of herders is given by:

$$L_g^* = L - L_T^*, \quad (32)$$

In a next step, we determine the number of employees per hotel by dividing (31) with the number of hotels m :

$$L_{h,i}^* = m^{\frac{(1-\eta)\alpha + 1}{(\eta-1)\alpha - (1-\beta)\eta - \beta}} \left(\frac{\alpha}{\beta^2}\right)^{\frac{(1-\eta)\alpha + \eta}{(\eta-1)\alpha - (1-\beta)\eta - \beta}} \left(\frac{(P^\delta)^{1-\eta} (\pi_g^*)^\eta}{\kappa Y_f^\epsilon}\right)^{\frac{-1}{\eta(1-\alpha-\beta) + \alpha + \beta}}, \quad (33)$$

Then, the equilibrium operational margin of a representative hotel (revenue minus labor costs) or ger camp becomes:

$$\Pi_{H,i}^* = \left(\frac{1-\beta}{\beta}\right) m^{\frac{(1-\eta)\alpha + 1}{(\eta-1)\alpha - (1-\beta)\eta - \beta}} \left(\frac{\alpha}{\beta^2}\right)^{\frac{(1-\eta)\alpha + \eta}{(\eta-1)\alpha - (1-\beta)\eta - \beta}} \left(\frac{(P^\delta)^{1-\eta} (\pi_g^*)^{(\eta-1)(\alpha+\beta)}}{\kappa Y_f^\epsilon}\right)^{\frac{-1}{\eta(1-\alpha-\beta) + \alpha + \beta}}, \quad (34)$$

If the operational margin equals the capital costs $rK_{H,i}$, the profits of hotels will become zero. This is the case if the number of hotels is:

$$m^{max} = \left(\left(\left(\frac{\beta}{1-\beta}\right) rK_{H,i}\right)^{(\eta-1)\alpha - (1-\beta)\eta - \beta} \left(\frac{\alpha}{\beta^2}\right)^{(\eta-1)\alpha - \eta} (\pi_g^*)^{(\eta-1)(\alpha+\beta)} (P^\delta)^{\eta-1} \kappa Y_f^\epsilon\right)^{\frac{1}{1+\alpha(1-\eta)}}, \quad (35)$$

As long as the number of hotels and ger camps is smaller than m^{max} , the hotel owners make positive profits. The equilibrium quantity of tourism goods is calculated by inserting the equilibrium price (30) in Equation (29):

$$X_T^* = \left(\left(\frac{\alpha}{\beta^2}\right)^{\eta\beta} m^{\eta(\beta-1)} (\pi_g^*)^{\eta(\alpha+\beta)}\right)^{\frac{1}{\eta(\alpha+\beta-1) - \alpha - \beta}} \frac{1}{P^\delta \eta (\kappa Y_f^\epsilon)^{\alpha+\beta}}, \quad (36)$$

From the macroeconomic view, the revenue of the tourism industry is most relevant for the country, because it indicates the contribution of tourism to the GDP. Hence, the revenue, R^* , is obtained as:

$$R^* = p_T^* X_T^* = \left(\left(\frac{\alpha}{\beta^2}\right)^{(\eta-1)\beta} \left(\frac{m^{(\eta-1)(\beta-1)} (\pi_g^*)^{(\eta-1)(\alpha+\beta)}}{P^\delta (\eta-1) \kappa Y_f^\epsilon}\right)\right)^{\frac{1}{\eta(\alpha+\beta-1) - \alpha - \beta}}, \quad (37)$$

Up to this point, we have determined the equilibrium values of all relevant economic variables. In what follows, we can analyze how a growing tourism demand and different policy measures influence the equilibrium values.

4. Analysis of Growth of Tourism and Policy Measures

Before we begin with the analysis, we make an additional assumption regarding the shift parameter κ . We assume that κ depends positively on marketing expenditure for holidays in Mongolia. Particularly, we assume for the rest of the paper the following functional relationship:

$$\kappa = M^\phi \tag{38}$$

with $\phi > 0$, where M are the expenditure for marketing Mongolia as a tourist destination.

As a first step, we calculate the elasticities of tourism industry’s relevant variables with respect to foreign income, public infrastructure, profits of herders, and number of hotels. In the following tables, we present the results, depending on the size of the price elasticity of demand. With the help of this outcomes, we will present the effects of tourism demand growth in the long-run in Section 4.1; in Section 4.2 we will analyze the effect of an environmental tax on goats on the equilibrium values; and in Section 4.3 we will analyze the effects of a lump-sum contribution paid by hotels to finance advertising for Mongolian tourism. In Section 4.4, we analyze the case that advertising expenditures are financed by a tax on operative profits.

The first row of Table 3 shows that a one percent increase in wage will lead to a decline in output. The reason is that hotels will increase their price and consequently reduce the quantity of their services. A one percent increase in the income of tourists increases the demand for tourism services, resulting in more services being supplied. An increase in public expenditure for infrastructure enhances productivity, thereby increasing output. Additionally, an increase in the number of hotels will also raise output, as it increases the variety of the composite good. An increase in the shift parameter similarly leads to an increase in output.

Table 3. Elasticity of output of tourism industry.

Output of Tourism Industry (Change in %)			
Increase of 1% of	Value of Elasticity	$\eta > 1$	$\eta < 1$
π_g^*	$-\frac{\eta(\alpha+\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	<0	<0
Y_f	$\frac{\varepsilon(\alpha+\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
P	$\frac{\delta\eta}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
m	$\frac{\eta(1-\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
κ	$\frac{(\alpha+\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0

Note: Calculated from (36). Source: Own calculations.

Table 4 above shows that an increase in herders’ income will lead to a decline in the number of employees, while an increase in the incomes of tourists will increase the number of employees. The effect on employment induced by an increase in public infrastructure spending strongly depends on the price elasticity of demand for tourism goods. If the demand for tourism is price inelastic, the number of employees will decline. The latter situation occurs because, given the wage rate, improved public infrastructure increases the labor productivity, and price inelastic demand induces hotels to lay off employees.

Table 4. Elasticity of number of employees in tourism.

Number of Employees (Change in %)			
Increase of 1% of	Value of Elasticity	$\eta > 1$	$\eta < 1$
π_g^*	$-\frac{\eta}{\eta(1-\alpha-\beta)+\alpha+\beta}$	<0	<0
Y_f	$\frac{\varepsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
P	$\frac{\delta(\eta-1)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	<0
m	$\frac{(1-\beta)(\eta-1)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	<0
κ	$\frac{1}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0

Note: Calculated from (31). Source: Own calculations.

Table 5 shows, an increasing demand for tourism caused by increased incomes of tourists, or more advertisement for Mongolia as tourism destination, or an increase of wages will lead to an increase of the tourism good’s price. An increase of the number of hotels and an improved infrastructure lowers the price.

Table 5. Price elasticity of composite tourism good.

Price of a Tourism Good (Change in %)			
Increase of 1% of	Value of Elasticity	$\eta > 1$	$\eta < 1$
π_g^*	$\frac{(\alpha+\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
Y_f	$\frac{\varepsilon(1-\alpha-\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
P	$-\frac{\delta}{\eta(1-\alpha-\beta)+\alpha+\beta}$	<0	<0
m	$-\frac{(1-\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	<0	<0
κ	$\frac{(1-\alpha-\beta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0

Note: Calculated from (30). Source: Own calculations.

Table 6 shows that the revenue of the tourism industry will undoubtedly increase when the demand for tourism increases due to higher tourist incomes or more advertising promoting Mongolia as a tourism destination. The effects on revenue caused by increasing wages, better infrastructure, and more hotels or ger camps depend on the price elasticity of demand for tourism.

Table 6. Elasticity of revenue of tourism industry.

Revenue of a Tourism Good (Change in %)			
Increase of 1% of	Value of Elasticity	$\eta > 1$	$\eta < 1$
π_g^*	$\frac{(\alpha+\beta)(1-\eta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	<0	>0
Y_f	$\frac{\varepsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
P	$\frac{\delta(\eta-1)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	<0
m	$\frac{(1-\beta)(\eta-1)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	<0
κ	$\frac{1}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0

Note: Calculated from (37). Source: Own calculations.

In general, it must be stated that tourism destinations facing price-inelastic demand for tourism have the problem that supply side policies (increasing productivity of the tourism industry) will result in declining industry revenue. In this case, one effective policy to increase industry revenue and its contribution to GDP is to invest in advertising and promotion of the country as a tourist destination. Otherwise, the revenue will have to depend solely on the income growth of tourists.

Table 7 clarifies the dependence of hotel profits on the price elasticity of demand, if the elasticity exceeds 1, supply side policies and declining wages increase the profits, and if the demand is sufficiently price elastic, an increasing number of hotels leads to an increase of profits of existing hotels. The reason for the latter effect is related to the fact that more hotels and ger camps imply an increasing variety, which makes the destination more attractive and more tourist will be willing to visit Mongolia. The increase of demand is so huge that all hotels will receive more customers.

Table 7. Elasticity of profit of hotels/ger camps.

Profit of a Hotel/ger Camp (Change in %)			
Increase of 1% of	Value of Elasticity	$\eta > 1$	$\eta < 1$
π_g^*	$\frac{(\alpha+\beta)(1-\eta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	<0	>0
Y_f	$\frac{\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
P	$\frac{\delta(\eta-1)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	<0
κ	$\frac{1}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	>0
		$\eta > \frac{1+\alpha}{\alpha}$	$\eta < \frac{1+\alpha}{\alpha}$
m	$\frac{1+\alpha(1-\eta)}{\eta(1-\alpha-\beta)+\alpha+\beta}$	>0	<0

Note: Calculated from (34). Source: Own calculations.

4.1. Growth of the Tourism Industry and Its Effect on Agriculture

To determine how the growth of foreign income, which is the main driver of tourism growth, influences the relevant variables, we assume that:

$$\frac{Y_{f,t+1} - Y_{f,t}}{Y_{f,t}} = 1 + \chi = X, \tag{39}$$

Using this growth factor, the growth factors of the dependent variables can be easily calculated. The respective growth factors are represented in the following Table 8:

Table 8. Growth factors.

Variable	Growth Factor
L_T^*	$X^{\frac{\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}}$
$\Pi_{h,i}^*$	$X^{\frac{\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}}$
p_T^*	$X^{\frac{(1-\alpha-\beta)\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}}$
X_T^*	$X^{\frac{(\alpha+\beta)\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}}$
R	$X^{\frac{\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}}$
m^{max}	$X^{\frac{\epsilon}{\alpha(1-\eta)+1}}$

Source: Own calculations.

Table 8 shows that employment in the tourism industry will increase with rising foreign income. The closer the price elasticity of demand is to 0, the higher the growth rates in the tourism sector. To derive the effect on the agricultural sector, we assume that the total working population L is growing with rate g_L . Then, the growth rate of the workers in the agricultural sector g_{L_g} becomes:

$$g_{L_g} = g_L - g_{L_T}, \tag{40}$$

where the growth rate of the labor force in the tourism industry $g_{L_T} = X^{\frac{\epsilon}{\eta(1-\alpha-\beta)+\alpha+\beta}} - 1$.

Considering real numbers, the population growth rate in Mongolia reached a peak of 2.2% in 2017 over the last 30 years, and now its value is 1.4%. In contrast, if we ignore the COVID-19 period (as an outlier), the tourism industry has grown on average by around 10% yearly in terms of visitors since 1995. The tourism industry is growing much faster than the Mongolian population, and therefore the tourism industry is attracting labor force from the agricultural sector, hence the difference (40) becomes negative. The share of labor force, which is engaged in the agricultural sector has declined from 50% in 1998 to 26% in 2023 (World Bank, 2024). Thus, we can state that the growing tourism industry is replacing the agricultural sector, with a positive impact on the environment.

4.2. An Environmental Tax

As noted earlier, Mongolia faces two very serious environmental problems: a large portion of its land is threatened by desertification, and its per capita GHG emissions are extraordinarily high. Both issues are related to the stock of animals used in the agricultural sector. For this discussion, goats will represent sheep, horse, cows, and goats, as mentioned earlier. The most straightforward approach to reducing the number of goats to protect the environment is to impose a tax on them. Therefore, we will analyze the effects of the tax on agriculture and the tourism industry. A tax rate of τ on each goat affects the optimal number of goats, and Equation (4) becomes:

$$g_\tau^* = \left(\frac{\gamma p_w D(S)}{c_w + \tau} \right)^{\frac{1}{1-\gamma}}, \tag{41}$$

with

$$\epsilon_{g,\tau} = \frac{\partial g_\tau^*}{\partial \tau} \frac{\tau}{g_\tau^*} = - \frac{\tau}{(1-\gamma)(c_w + \tau)} < 0, \tag{42}$$

Obviously, the optimal number of goats per herder declines with an increasing tax rate. Particularly, the elasticity $\epsilon_{g,\tau}$ indicates that the effect is relative huge, when the exponent γ is relatively close to 1. We presume that this is probably the case, because if the exponent is close to 1, the production function of wool per capita is almost linear.

Now we will consider the effect of an environmental tax on the income of herders. The per capita income with the tax becomes:

$$\pi_{g,\tau}^* = (1-\gamma)(p_w D(S))^{\frac{1}{1-\gamma}} \left(\frac{\gamma}{c_w + \tau} \right)^{\frac{\gamma}{1-\gamma}} > 0, \tag{43}$$

with

$$\epsilon_{\pi_{g,\tau}^*} = \frac{\partial \pi_{g,\tau}^*}{\partial \tau} \frac{\tau}{\pi_{g,\tau}^*} = - \frac{\gamma \tau}{(1-\gamma)(c_w + \tau)} < 0, \tag{44}$$

The elasticity $\in_{\pi_g^*, \tau}$ informs us that the income declines in terms of percent caused by increase of the environmental tax by 1% is smaller than the decline of goats in terms of percent. In a last step, we calculate the tax revenue elasticity. The tax revenue is given by:

$$T_\tau = \tau \left(\frac{\gamma p_w D(S)}{c_w + \tau} \right)^{\frac{1}{1-\gamma}}, \quad (45)$$

The elasticity of the tax revenue with respect to the tax rate becomes:

$$\in_{T_\tau, \tau} = \frac{\partial T_\tau}{\partial \tau} \frac{\tau}{T_\tau} = \frac{c_w - \gamma(c_w + \tau)}{(1-\gamma)(c_w + \tau)} \begin{cases} \geq 0, & \text{if } \tau \leq \frac{1-\gamma}{\gamma} c_w \\ < 0, & \text{if } \tau > \frac{1-\gamma}{\gamma} c_w \end{cases}, \quad (46)$$

Not surprisingly, the reaction of the tax revenue's sign depends on the size of the tax rate. If the tax rate is relatively high, the tax revenue will decline; otherwise, it will increase. Having calculated the elasticities of the number of goats and income with respect to the environmental tax, we can consider the effects of the tax on the tourism industry. Because the tax rate should be determined by environmental requirements rather than the goal of maximizing tax revenue, it is recommended to redistribute the tax revenue in a lump-sum manner to herders and employees in the tourism industry, as these individuals are negatively affected by the tax.

We examine the direct effects of the tax on the number of employees in the tourism industry, the operating margins of hotels, the price and quantity of tourism goods, and the overall revenue of the tourism industry. To obtain the results, we multiply $\in_{\pi_g^*, \tau}$ with the respective elasticities derived in the tables above.

The respective elasticity of the employment in the tourism industry with respect to the tax rate becomes:

$$\in_{L_T^*, \tau} = \in_{\pi_g^*, \tau} \in_{L_T^*, \pi_g^*} = \frac{\eta \gamma \tau}{(\eta(1-\alpha-\beta) + \alpha + \beta)(1-\gamma)(c_w + \tau)} > 0, \quad (47)$$

Because of the declining incomes of herders, some herders will try to obtain a job in the tourism industry, so that the wages in the tourism industry adjust to the income of herders. Hence,

$$\in_{\Pi_{H,i}^*, \tau} = \in_{\pi_g^*, \tau} \in_{\Pi_{H,i}^*, \pi_g^*} = - \frac{(1-\eta)(\alpha + \beta)\gamma\tau}{(\eta(1-\alpha-\beta) + \alpha + \beta)(1-\gamma)(c_w + \tau)} \begin{cases} \geq 0, & \text{if } \eta \geq 1 \\ < 0, & \text{if } \eta < 1 \end{cases}, \quad (48)$$

This mean that an increase in the tax rate leads to an increase in the operating profits of hotels, given that the price elasticity of tourism demand is elastic. Hotels can offer their services at a lower price because the wages of their employees have declined, as noted below:

$$\in_{p_T^*, \tau} = \in_{\pi_g^*, \tau} \in_{p_T^*, \pi_g^*} = - \frac{\gamma\tau(\alpha + \beta)}{(1-\gamma)(c_w + \tau)(\eta(1-\alpha-\beta) + \alpha + \beta)} < 0, \quad (49)$$

Because of the declined wages, the price of the tourism good decreases, while the quantity supplied increases, i.e.,:

$$\in_{X_T^*, \tau} = \in_{\pi_g^*, \tau} \in_{X_T^*, \pi_g^*} = \frac{\gamma\tau(\alpha + \beta)\eta}{(1-\gamma)(c_w + \tau)(\eta(1-\alpha-\beta) + \alpha + \beta)} > 0, \quad (50)$$

Now we derive the reaction of the revenue of the tourism industry as follows:

$$\epsilon_{R^*,\tau} = \epsilon_{\pi_g^*,\tau} \in_{R^*,\pi_g^*} = \frac{\gamma\tau(\alpha + \beta)(1 - \eta)}{(1 - \gamma)(c_w + \tau)(\eta(1 - \alpha - \beta) + \alpha + \beta)} \begin{cases} \geq 0, & \text{if } \eta \geq 1 \\ < 0, & \text{if } \eta < 1 \end{cases} \quad (51)$$

Obviously, the effect of the environmental tax is ambiguous, depending on the price elasticity of demand for tourism.

Proposition 1: *The introduction of an environmental tax lowers the income of herders and employees in the tourism industry, and both lowers the price of the composite tourism good and increases its quantity. If the price elasticity of tourism demand is elastic, the tax causes an increase of the profit of hotels and the revenue of the tourism industry and its contribution to GDP.*

This result does not imply that the income reduction caused by the environmental tax can be fully compensated, but the existence of the tourism industry lowers the burden for herders by offering new job opportunities.

4.3. Lump-Sum Financed Advertising Expenditures

In general, there is only one opportunity to enhance international tourism demand and that is to advertise Mongolia as a tourism destination. The simplest way to do this is to require from hotels, which benefits from the lower wages caused by the environmental tax, a lump-sum contribution. It is important to ensure that this contribution does not ruin the hotels, but if the advertising promotes Mongolia as a tourist destination, this contribution has the characteristic of a public good. Using (38), we substitute κ by M^ϕ , with $\phi > 0$, where M are the total expenditures for advertising and each hotel must bear an equal share $\frac{M}{m}$. This means that the profits of hotels are reduced by this amount, but on the other hand, the hotels benefit from the additional demand created by advertising. To derive the effects, we calculate respective elasticities, i.e., the elasticities of number of employees in tourism sector, the tourism’s good price, the tourism’s good quantity, and the tourism’s revenue. The results are presented in the following table (Table 9).

Table 9. A 1% increase of expenditures for advertising M causes.

Variable	Name of Elasticity	Change in %
Employment in tourism industry	$\epsilon_{L_T^*,M}$	$\frac{\phi}{\eta(1-\alpha-\beta)+\alpha+\beta} > 0$
Price of tourism good	$\epsilon_{p_T^*,M}$	$\frac{(1-\alpha-\beta)\phi}{\eta(1-\alpha-\beta)+\alpha+\beta} > 0$
Quantity of tourism good	$\epsilon_{X_T^*,M}$	$\frac{(\alpha+\beta)\phi}{\eta(1-\alpha-\beta)+\alpha+\beta} > 0$
Revenue of tourism industry	$\epsilon_{R^*,M}$	$\frac{\phi}{\eta(1-\alpha-\beta)+\alpha+\beta} > 0$

Source: Own calculations.

Proposition 2: *An increase of contribution-financed advertising expenditures leads to an increase of employment in tourism industry, an increase of the price of the tourism good, an increase of the quantity of tourism good, and an increase of the revenue of the tourism industry.*

As employment in the tourism industry increases, the number of herders and goats will decline. Consequently, the environmental damages caused by agriculture will also decrease. The effectiveness of advertising efforts will increase as the price elasticity of demand for tourism goods decrease.

4.4. A Tax on Operative Profits and Advertising Expenditures

Here, we consider another proposal, which is to tax the hotels' profits and to use the tax revenue for financing marketing and advertising Mongolia as a tourism destination. Of course, the tax must be sufficiently small to ensure that hotels do not run losses as a result. Using (38), we substitute κ by M^ϕ , where M is determined by the implicit equation:

$$M = \tau_p m \left(\frac{1-\beta}{\beta} \right) m^{\frac{(1-\eta)\alpha+1}{(\eta-1)\alpha-(1-\beta)\eta-\beta}} \left(\frac{\alpha}{\beta^2} \right)^{\frac{(1-\eta)\alpha+\eta}{(\eta-1)\alpha-(1-\beta)\eta-\beta}} \left(\frac{(P^\delta)^{1-\eta} (\pi_g^*)^{(\eta-1)(\alpha+\beta)}}{M^\phi Y_f^\varepsilon} \right)^{\frac{-1}{\eta(1-\alpha-\beta)+\alpha+\beta}} \quad (52)$$

Solving for M delivers:

$$M = \left(\left(\tau_p \frac{1-\beta}{\beta} \right)^{\eta(\alpha+\beta-1)-\alpha-\beta} \left(\frac{\alpha}{\beta^2} \right)^{\eta(1-\alpha)+\alpha} (P\pi_g^*)^{\delta(\eta-1)} (Y_f)^{-\varepsilon} \right)^{\frac{1}{\eta(\alpha+\beta-1)-\alpha-\beta+\phi}}, \quad (53)$$

We make the technical assumption that $\phi < \eta(1 - \alpha - \beta) + \alpha + \beta$, otherwise the tax revenue M declines with an increasing tax rate τ_p .

Inserting the expression of M in the relevant variables like profit of employment in the tourism industry, hotel profits, price of the tourism good, quantity of tourism goods, and revenue of the tourism industry, we calculate the following elasticities:

$$\epsilon_{(1-\tau_p)\Pi_{H,i}^*, \tau_p} = \frac{\phi - \tau_p(\eta(1 - \alpha - \beta) + \alpha + \beta)}{(1 - \tau_p)(\eta(1 - \alpha - \beta) + \alpha + \beta - \phi)} > 0, \quad (54)$$

The net contribution margins of hotels increase, given that tax rate is not too high and the elasticity of demand for tourism is not too inelastic.

The effect on employment is given by:

$$\epsilon_{L_T^*, \tau_p} = \frac{\phi}{\eta(1 - \alpha - \beta) + \alpha + \beta - \phi} > 0, \quad (55)$$

If $\eta(1 - \alpha - \beta) + \alpha + \beta > \phi$, the employment in the tourism industry will increase and the number of herders and goats will decline.

Regarding the price of the tourism good, we obtain the following outcome:

$$\epsilon_{p_T^*, \tau_p} = \frac{\phi(1 - \alpha - \beta)}{\eta(1 - \alpha - \beta) + \alpha + \beta - \phi} > 0, \quad (56)$$

An increase of the tax will cause the price of the tourism to increase. The quantity of the tourism good also increases because of the increased demand for tourism offered in Mongolia.

$$\epsilon_{X_T^*, \tau_p} = \frac{\phi(\alpha + \beta)}{\eta(1 - \alpha - \beta) + \alpha + \beta - \phi} > 0, \quad (57)$$

To investigate the impact on revenue, we analyze the reaction of the revenue, where it is clear from (54) and (55) that the effect is positive.

$$\epsilon_{R^*, \tau_p} = \frac{\phi}{\eta(1 - \alpha - \beta) + \alpha + \beta + \phi} > 0, \quad (58)$$

Proposition 3: *The mechanism to finance expenditures with a tax on the operative profits of hotels leads to an increase in the price of tourism goods, the quantity of tourism goods, the labor force in the tourism industry, and the increase of revenue.*

However, it must be considered that the remaining net contribution margins need to cover the capital costs of the hotels. Additionally, a declining rate of return after taxes reduces the probability of attracting investors in the long run. The increasing labor force in the tourism sector, however, implies a declining number of herders and, therefore, a declining number of goats. Consequently, the environmental damage caused by herding will also decrease.

5. Discussion

In the previous section, we have shown that different policy measures may lead to a structural shift of economic activities from the agricultural to the tourism sector. Because economic activities in the agricultural sector are more environmentally harmful than economic activities in the tourism sector of equal value, the total environmental damages caused by economic activities will be reduced.

Thus, the development of tourism leads to less environmental damage if the economic activities replaced by the tourism sector are more environmentally harmful than tourism. This statement holds in general, but it also means that this result will be more likely to occur the more environmentally friendly the tourism activities are and the better the tourism industry is set up.

Without any doubt, one weakness of this paper is that our analysis is restricted to economic consequences, and it ignores the social and cultural changes and necessary adaptations associated with changes in the economic structure. These non-economic changes should not be underestimated by policymakers, and they must consider political opposition from herders and other parts of society. However, addressing this challenge and resolving it must be left to politics.

Another obvious weakness of this paper is that the data regarding Mongolia is often ambiguous or missing altogether. We addressed this problem to some extent by taking very conservative estimates. However, we reiterate the need to have reliable data for meaningful political decisions, and hence recommend that Mongolian politicians rectify this shortcoming immediately. Furthermore, given a better database in the future, the model and its implications can be tested empirically in detail.

Another restriction is that we only considered two economic sectors in our model, although Mongolia has more than two economic sectors, and the most important one in the case of Mongolia is the mining industry. However, the income of miners in Mongolia, like in many post-Soviet countries, is disproportionately higher than in all other sectors, and in the remote areas where tourism takes place, the only alternative economic activity is agriculture and farming. Because of these circumstances, we are convinced that the model presented is a good approximation to reality.

6. Conclusions

In this paper, we aim to demonstrate two things: first, that tourism can help reduce greenhouse gas emissions, and second, that Mongolia fulfills the conditions such that the expansion of tourism can achieve the dual objective of reducing its greenhouse gas emissions and counteracting the desertification of its grasslands. The decisive factor in determining whether tourism can support environmental protection is whether the economic activities displaced or replaced by the growth of tourism have a worse environmental impact than tourism. Therefore, the model provides a theoretical foundation for why some

empirical studies concluded that increasing tourism has reduced GHG emissions while others have not. Our model shows that while tourism itself causes environmental impacts, if developed sustainably, it can help reduce environmental damage, provided that certain country-specific conditions are met.

Undoubtedly, tourism activities are also associated with pollution and greenhouse gas emissions, especially when tourists travel by airplane. Despite limited or sparse data, we were able to show that, for the Mongolian economy, every dollar generated in the tourism industry is associated with only a fraction of the greenhouse gas emissions compared to those generated by Mongolian agriculture. This is primarily because over 90% of Mongolian agriculture is based on extensive livestock farming. Another issue induced by the growth of livestock farming is the increasing desertification of grasslands, which threatens the existence of agriculture.

Using a theoretical economic model that accounts for both the tourism economy and the agricultural economy, we show that a tax on livestock, acting as an environmental tax, not only reduces livestock numbers, but also increases the labor supply available to the tourism industry. Consequently, the costs for providers of tourist goods will fall, making Mongolian tourism more attractive to international tourists. However, a positive effect for the tourism industry only occurs if the price elasticity of tourism demand is elastic. If this is not the case, it is advisable to promote Mongolia more vigorously as a tourist destination to generate a positive effect. Specifically, we show that marketing expenditure, financed either by a tax on hotel profits or by a fixed contribution from each hotel, can increase hotel profits and, in principle, contribute to higher value creation in the tourism industry.

Future research should focus on alternative sectors driving the economic growth of Mongolia, including sectors like education and technology, because such activities may support not only the development of the economy, but also help to make tourism more environmentally friendly. Particularly, the model should be extended by incorporating human capital to consider possible transaction costs associated with the structural change of the economy.

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Note

¹ In principle, the equation should be written as $\Delta S_t = vS_t \min\left(0, 1 - \frac{S_t}{S_{max}}\right) - sG_t$.

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