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The impact of competition for picking wild edible mushrooms and the opportunity cost for rural communities: the case of Castile and León (Spain)

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Picking wild edible mushrooms is a key activity both for rural as well as urban communities. Studies into the topic support the notion of the major socio-economic benefits, which increase both producer as well as consumer surplus. However, to date, no study has estimated picking harvests in the way this study does or what effects these might have on local communities with regard to other activities, both in terms of work and leisure time. This study explores both issues, taking as an indicator a variable used in conventional analysis in other sectors, yet which thus far has not been employed in wild edible mushroom picking: productivity value. The chosen study area is the autonomous community of Castile and León, a Spanish region with an important and long-running mycological tradition. Using the decision-making method between individuals' leisure time and work time, the authors test the corresponding hypotheses. The results that emerge for the years analyzed (2013 and 2014) support the hypothesis of distorting/moderating effects related to the effects of picking yields on pickers' income and their impact on the individual supply for labor function of pickers.

KEYWORDS

wild edible mushrooms, picking yields, hourly wage comparison, labor market and rural areas, Castile and León

1 Introduction

Picking wild edible mushrooms has formed part of the daily livelihood of rural families in many countries for centuries (Boa, 2004). Today it plays a key role, both due to its importance in daily diet through self-consumption (Dijk et al., 2003; Christensen et al., 2008) and because of the contribution it makes to family income when sold in local markets (Turtiainen et al., 2012; Manna and Roy, 2014; Larios-Trujillo et al., 2019). Several studies have sought to describe the species harvested by local communities in various countries, analyzing picking habits and the link to socio-economic characteristics (Guissou et al., 2008; Montoya et al., 2008; Shepard et al., 2008). Other authors have addressed the case of species that are particularly important in markets (Román and Boa, 2006; He et al., 2011; Thapa et al., 2014; Zulu et al., 2019). Other studies have sought to ascertain the importance of commercializing the wild edible mushrooms picked, the financial return obtained and the impact on rural

family economies (Pérez-Moreno et al., 2008; Cai et al., 2011; Martínez de Aragón et al., 2011; Tibuhwa, 2013; Ei et al., 2019). Finally, some works have compared the economic importance of wild edible mushrooms to that of other forest products (Alexander et al., 2002; Sisak et al., 2016).

However, researchers have thus far centered their attention on estimating picking returns, focusing the analysis on estimations of the forest's productivity as a production factor. This approach –based on studying the capacity to generate natural capital income– is very common, not only in the mycological sector, but also in other activities that can generate income, such as silviculture, hunting, etc. (Campos et al., 2019). Yet, to the best of our knowledge there are no studies that adopt a focus from the standpoint of labor as a production factor and, therefore, of what influence labor market characteristics might have on the harvesting of edible wild mushrooms. In other words, the topic has not been approached from the perspective of the time dedicated to picking in the form of hours devoted to this activity (Palahi et al., 2009), or at least in a meaningful way. As a result, this study posits an analysis based on picking returns per hour dedicated rather than on returns per unit of available forest area. We therefore put forward the notion that the time dedicated to picking has an opportunity cost, regardless of whether or not the picker also has a paid job.

The aim of the present research is therefore to estimate individuals' returns from picking, measured in euros per hour for the various groups, distinguishing between pickers according to their place of residence. We posit this as an explanatory variable which might influence a picker's decision when deciding whether to spend more or less time on the activity, measured in the number of hours spent picking in relation to other paid activities or alternative leisure activities. To achieve our aim, we investigate the most widely picked species in terms of picker profile, what weight the species have in the harvest obtained, and the relative importance of each chosen group. Based on this, an estimation is made of yields and monetary returns from picking per hour –depending on the picker's place of residence– and comparisons are drawn with the various hourly wage components.

The present research thus seeks to answer three major challenges. Firstly, we aim to offer valuable information for resource managers – particularly in those areas of the world that base their control of the resource through the issuing of picking permits (de Frutos et al., 2019). Sale of such permits tends to be carried out fairly inefficiently, since it is not known how many permits may be sold in relation to the resource potential. Erroneous decisions might therefore compromise the sustainability of the resource if the amount picked were to exceed the amount regenerated (Egli et al., 2006). Although there are quite a few studies that deal with the second issue (Bonet et al., 2014), the same cannot be said for the first. Having indicators available of the amounts collected –measured in the form of productivity– is key to ensuring that decisions are made taking into account environmental sustainability criteria. The present work thus quantifies pickers' yield in accordance with their characteristics which, under certain hypotheses, are developed in the present document, and which may be extrapolated to other areas. In other words, this information may be used by managers in other regulated areas to calculate the extraction indices of the resources in a given area and then make comparisons to the potential thereof.

Secondly, this study seeks to offer methodological improvements, particularly with regard to how the information is gathered and how it is interpreted. To date, no studies are known that have attempted to make such estimations. This work specifically explains the methodological procedure employed –both in terms of collecting the information and making the estimations of yields as well as drawing comparisons with the relevant variables in order to test the study hypotheses. We therefore posit robust estimations of harvests for an activity in which –due to various circumstances (de Frutos et al., 2008)– obtaining reliable data proves extremely costly and complex. The method used to obtain the data may also be seen as a major step forward in terms of addressing this problem. Moreover, to the best of our knowledge, no attempt has yet been made to link this information in the activity to individuals' opportunity cost of time. Although the scientific literature in this regard is varied, no application has ever made to the area in question here, as will be seen in the following section. The third and final challenge involves providing the scientific community with the information required to address studies related to the development of certain emerging activities –such as mycotourism– from the standpoint of sustainability (Rovira et al., 2022; Suazo and Viana-Lora, 2022; Latorre et al., 2023) or through adopting bio-economy based approaches (Huber et al., 2023).

To achieve these objectives, this article is organized as follows. The following section sets out the research hypotheses, conducting a literature review so as to adapt the theoretical contributions related to individuals' opportunity cost of time to the subject matter. The Methods and Materials section then looks at the area studied, data sources and the method applied to conduct the estimations and comparisons between relevant indicators. We then set out the principal results schematically before finally moving on to the discussion thereof based on findings from other studies. Finally, we put forward the principal conclusions to emerge based on the main hypotheses put forward, together with the references used in the research.

2 Study hypothesis: literature review

The opportunity cost of individuals' time and its link to the wage received has been amply dealt with in scientific literature since the 1960s (Haney, 1967; Lee and Dalvie, 1969; McGillivray, 1972; Watson, 1974). All of these studies concluded that one part of workers' hourly wage correctly explained the decision to choose one means of transport over the other. Years later, the debate shifted to the opportunity cost of leisure time in individuals' recreational trips (Cesario and Knetsch, 1970; Cesario, 1976; McConnell and Strand, 1981; Riera, 1997). As a result, close to 50% of the hourly wage might be deemed a good indicator that would help to estimate more accurately the well-being generated by this type of trip and the corresponding consumer surplus.

Yet the debate surrounding opportunity cost with regard to leisure time and how it might be evaluated is not without controversy. Firstly, it is by no means clear that individuals can choose freely between leisure time and work time in their labor contracts. Indeed, most workers cannot, such that this relation would be totally inelastic to opportunity cost, and the wage, or a part thereof, would not influence the decision (Bockstael et al., 1987). Secondly, it is important not to confuse the notion of opportunity cost of time with the value that an individual places thereon (Ward, 1983). This latter notion would vary among individuals, and the wage or a part thereof could not be used to estimate it (Shaw, 1992; McKean et al., 1995). A third sticking point

concerns the fact that the time devoted to an activity sometimes generates satisfaction in the individual where, as a result, the notion of opportunity cost would make no sense (Walsh et al., 1990).

This latter aspect is particularly important in the present research, where the amount of time that pickers decide to devote to the activity can generate satisfaction in them or not, depending on the type of picker. The literature in this regard has tended to define two types of pickers depending on the ultimate use to which the yield will be put; commercial pickers, who sell what they pick in markets, and non-commercial pickers, who use what they pick for self-consumption. In both instances, it is assumed that the time dedicated to picking should be treated as input in their production function, particularly for the former, since the time dedicated to picking represents a source of income and contributes to the family budget. Several studies have estimated this contribution (Alexander et al., 2002; Palahi et al., 2009; Cai et al., 2011; Voces et al., 2012), in which there should be a component of the opportunity cost of the time devoted to picking in relation to the time dedicated to other production or leisure activities.

Yet over the last few years a new kind of picker has emerged; those who devote part of their leisure time to picking (recreational pickers), where the time invested offers a source of satisfaction. These pickers do not behave as production units who seek to maximize their income and minimize their costs (including the time spent picking), as is apparent in the previous cases, but act as utility maximizers who are subject to budgetary restrictions (de Frutos Madrazo et al., 2016). The literature in this regard tends to refer to this type of picker as mycotourists (Büntgen et al., 2017), who engage in an activity that has become a further driver of development in disadvantaged rural areas (de Frutos Madrazo et al., 2012). As a result, in these cases one cannot talk of the opportunity cost of the time devoted to picking, nor much less attempt to evaluate it through an hourly wage or a part thereof. Whatever the case, the wage per unit of time continues to provide a good approach for measuring the opportunity cost of time (Parsons, 2003).

The first hypothesis addresses the possible existence of competition for picking. There is the notion that the significant expected return attracts non-local pickers who compete for access to this forest resource. An increase in the value of the product collected is thus expected to attract new pickers to the area, which might spark conflict among pickers who are seeking to access the same scant resource. This competition effect will depend on how ownership rights over the resource are defined and how such rights are enforced in practice. There are many different examples worldwide of how societies have allocated ownership rights, such as the cases put forward by Merlo and Rojas Briales (2000), who draw a clear distinction between the contrasting solutions found in northern European countries compared to southern European countries in terms of their idiosyncrasy and historical background. Depending on the way in which such rights are handled, undesirable situations may emerge between the groups who actually do possess the ownership rights and those think they do –if the situation is not clear for the two parties in question. This might trigger problems of poaching (La Pierre, 1994) or even over-exploitation of certain species, which could jeopardize their long-term survival (Jansen, 1990; Arnolds, 1991; Fellner, 1993; Bonet et al., 2020). This would clearly compromise the resource's capacity to act as a driver of development for local communities. For example, local pickers might be subject to two-fold competition when picking: first, from those who also pick in to sell or for their own consumption but who do not live in the area; secondly, they might also face competition to access the resource from non-commercial pickers who seek other intangible benefits beyond the actual edible wild mushrooms –namely, mycotourists (Latorre et al., 2021). This new activity –which is yet to be included in resource management in many countries–might pose problems of access thereto, given that even if ownership rights were clearly defined these new pickers might assume that they too enjoy such a right, should the management system fail to clearly demarcate the limits of access to picking.

The second hypothesis concerns the existence of a substitution effect between picking and other production activities, whether in relation to others that generate income or to those not carried out during leisure time. In this case, the time which local inhabitants devote to picking implies an opportunity cost. An increase in the value of the product in mushroom markets is thus expected to act as an incentive for pickers to take decisions in other markets –such as the labor market– given the substitutability link between the time devoted to work and to other leisure activities, or picking in this case. In other words, an increase in the mentioned variable would mean more hours being devoted to picking and fewer hours being given over to work – depending on the type of contractual relationship between picker and employer. When picking, people would thus be foregoing the chance to receive income from other sectors or would be forfeiting the opportunity to engage in other leisure activities, if the activity indeed detracted from the time spent doing other leisure activities or from resting. Although –as pointed out– there is ample scientific literature addressing the opportunity cost of time with regard to decision-making concerning work and leisure, to date, no research has addressed what effect this might have on the local labor market in depopulated rural areas. Some studies have sought to ascertain how to value the link between wages and the time devoted to other activities that are not necessarily leisure. For example, one related line of inquiry concerns whether the hours devoted to work may be used as a means of payment or as a contribution to certain causes in countries with lower levels of development (Tegegne, 1999). In this case, the issue emerges as to whether the wage not received in the labor market during the voluntary contribution correctly measures the willingness to pay for said contribution (Hung et al., 2007; Tilahun et al., 2015). Underlying this notion is the idea that in communities with low levels of income the willingness to pay in monetary terms for helping to solve a problem which affects the community might be underestimated and would not be correctly reflecting individual preferences (Susilo et al., 2017). As a result, wages –which are daily in this case– have been widely used as a variable that correctly measures the opportunity cost of time in monetary terms. It has thus been used as a vehicle of payment when applying the contingent valuation method to value certain non-market public goods. This has been applied to valuing marine resources (O'Garra, 2009; Susilo et al., 2017), forest fire prevention and protection of forest areas (Hung et al., 2007; Tilahun et al., 2015) or for pest and disease control (Swallow and Woudyalew, 1994; Echessah et al., 1997; Arbiol et al., 2013). Although these studies are not linked to the topic dealt with in this research, all of them do clearly show the importance of taking into account the opportunity cost of time when this is dedicated to alternative activities –whether leisure activities or not– and how this is measured through wages paid in the labor market.

10.3389/fsufs.2024.1474624

There might then be situations in which firms would have to compete with mushroom picking for a labor force that, in areas suffering from depopulation, might be scarce. Depending on the expected income to derive from mushroom picking there might be an incentive to sacrifice other types of part-time or full-time work, not only vis-à-vis seasonal work but also with regard to permanent employment. There could also be situations in which individuals might prefer to enjoy their holidays and rest periods engaging in their usual occupation during the picking period and forfeiting part of their leisure time, depending on the expected return. Such might be case of people who decide to ask their employer for time off (to which they are entitled under labor law) during the harvesting season in to pursue this activity. This would affect the normal running of their firm if a number of workers decided to do this or if the company were only small (which is common in areas such as these). Both issues would affect the normal functioning of the labor market in the rural area in question.

In both instances, the explanatory variable that would determine how important this is would be the expected productivity from picking, measured in the form of returns from engaging in the activity. Few authors have explored the impact of economic variables such as picker productivity and its link to rural development in more disadvantaged areas (Bonet et al., 2014; Yilmaz and Zencirci, 2016). These two studies are, however, insufficient to estimate the scale of the expected effects. A conventional productivity measure, such as the productivity value per unit of time for pickers, would need to be estimated to make the required comparisons and so explore what influence they might have, both in terms of competition over the resource as well as the substitution effect in the labor market.

3 Methods and materials

3.1 Study site

Located in central Spain, Castile and León is an autonomous community covering over 94,000 km^2 (41°38′21″N 4°25′49″W). According to the European Union classification of Territorial Units for Statistics, Castile and León is the third largest level two territorial unit (NUTS 2) in the whole of the European Union (Figure 1) and is similar in size to countries such as Austria or Portugal. It has nine NUT 3 (provinces) territorial subdivisions and 2,248 lower levels (municipalities). The Nomenclature of Territorial Units for Statistics (NUTS) was drawn up by the EU's statistical office (Eurostat) in order to provide a single uniform breakdown of territorial units for the production of regional statistics. The territory of the EU is subdivided at 3 different geographical levels. In first NUTS 1 or major socio-economic regions with a population ranging from 3 to 7 million, in second, NUTS 2 or basic regions generally used for the application of regional policies with a population ranging from 800,000 to 3 million and finally NUTS 3 or small regions for specific diagnoses with a population ranging from 150,000 to 800,000. Regions eligible for support under the EU's cohesion policy are defined at NUTS 2 level (Regulation (EC) No 1059/2003 formally established the NUTS in 2003).

Castile and León boasts important natural wealth. Over 50% of the region is classified as forest and 31% is woodland, representing 15% of the national total and it is the region with the greatest total forested area. There are almost three million hectares of woodland, of which over two-thirds is densely forested. As regards mycological resources, the region has over 15,000 km^2 of forests suitable for wild edible mushroom picking, for both commercial and recreational

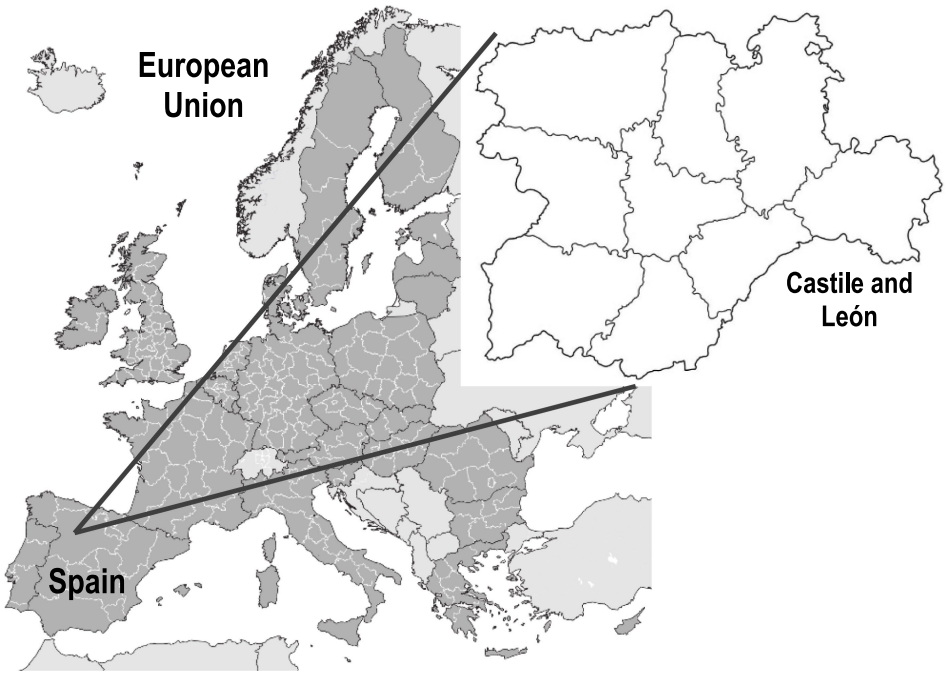

FIGURE 1
Castile and León location map.

purposes. Particularly extensive and productive in this region are the acid coniferous forests (*Pinus sylvestris* L. and *Pinus pinaster* Ait.) where most of the harvesting takes place. Fungal diversity covers over 2,700 species, including the main species of commercial interest worldwide, such as Boletus edulis Bull., Lactarius deliciosus (L.) Gray, Cantharellus spp., Morchella spp.… Commercial use of wild edible mushrooms in the area is relatively recent, commencing in the 1960s and continuing until the 1990s when recreational use gradually replaced commercial use. Nowadays, most use is recreational and for mycotourism, and coexists with commercial harvesting in areas of high production or when there is a bumper crop. According to Martínez-Peña (2015), it is estimated that 54% of the population regularly engage in collecting and valorizing wild edible mushrooms. Consequently, an annual value of 65 million euros is generated, with wild mushrooms being the main non-wood forest product (NWFP) in the region.

The system governing the picking of wild mushrooms in the region, known as MICOCYL, has been in place since 2003. It is one of the most advanced models for managing the forest use of wild edible mushrooms currently in existence (de Frutos Madrazo et al., 2019). This joint bottom-up governance model today includes over 360 public forest owners (mainly local rural municipalities) and covers more than 430,000 regulated hectares belonging to over 760 forest holdings spread throughout the region, split into 245 municipalities. According to Bonet et al., 2020, countries generally fall into two categories: first, nations with weak economies, usually with a significant local tradition of collecting and selling wild edible mushrooms, and second, wealthier countries that import but that may not have a strong tradition of picking for selling. The region selected as the study site can be considered representative of south-western European populations with a mycophilic tradition and closely linked to the consumption of many different species of edible mushrooms. Due to its strategic position, accessibility and myco-touristic development, we find both categories of wild edible mushroom use: picking for selling and for recreational purposes. It is considered a suitable site for transferring results to other areas.

3.2 Data sources

Estimations are carried out using actual yield data, a thus far unexplored aspect in research –to the best of the authors' knowledge. All of the studies referred to make their estimations based on surveys conducted among pickers; in other words, in terms of what they claim to have picked and not what they have actually picked. In our case, data collection is based on compulsory (not voluntary) in-situ forest controls carried out among pickers during the mycological seasons in 2013 and 2014 by national law enforcement authorities –forest rangers in this case– who are authorized to impose fines. One noticeable fact might be that these data are 10 years old but were not made available to the research team by the competent authority until years later. However, we do not believe that this makes the results calculated and their corresponding interpretation any less important. This is because the study is based on estimating labor productivity variables that barely change over the years, unless there are major technological developments (Fagerberg, 2000). This is unlikely, however, given the way in which picking takes place (de Frutos et al., 2008). In this regard, the rules governing picking –prohibiting the use of certain implements or tools that might increase the amount picked– have also remained unchanged. Such rules are mainly geared toward ensuring sustainability (Regional Government of Castilla and León, 2017).

Controls on pickers were conducted by forest and environmental rangers from the Regional Government of Castile and León following the instructions issued by the Directorate General for the Environment and the conditions set out under Decree 130/1999 of 17 June, which establishes the regulations governing the use of mycological resources in woodlands located in the region of Castile and León, under the responsibility of each Territorial Environmental Service in accordance with the material and human means available to undertake the task (Regional Government of Castilla and León, 2014). A total of 1,581 controls (observations) were carried out during the 2013 season and 3,320 in the 2014 season, of which 1,533 and 3,244, respectively, were considered valid for this study. Once the quality tests had been carried out on the samples, 40 observations for 2013 and 76 for 2014 were therefore deemed not to be valid. The controls were conducted in forests declared to be of public use from September to late November, with most being carried out in October and November. Over 30% took place at weekends. A total of 493 public use forests were controlled, with 51% of the controls being carried out in forests regulated under the MICOCYL model.

For each control carried out, the forest rangers had to collect the information filling in a scoreboard which covered three types of information: firstly, information concerning the place where the picking was taking place as well as the date, province, public utility forest and whether or not the latter was regulated by MICOCYL. Information was also collected on the pickers themselves, such as their place of origin, whether they had a permit or not and, if so, what kind, as well as whether or not they were in possession of an authorized basket together with how many they had depending on whether they were adults or under 14 years of age, and whether any infringements needed to be reported. Secondly, information was gathered regarding the characteristics of the day's harvest up to the time of the control, such as the total weight picked, the time spent picking, the species picked and the minimum diameter of each of the species controlled. These were chosen due to their socio-economic importance in the picking areas based on previous studies (Martínez-Peña et al., 2011). Specifically, the following species were selected: Boletus edulis Bull., Lactarius deliciosus (L.) Gray, Pleurotus eryngii (DC.) Quél., Amanita caesarea (Scop.) Pers. and Cantharellus cibarius Fr. since, from a commercial standpoint in Europe, these are the main species (Bonet et al., 2020). The remainder of the content in the baskets was classified as "other species." Finally, information noted down by the ranger was also collected. This included the weather conditions or visibility, and vehicles spotted near the control area or the estimated picking and livestock intensity in the immediate area.

3.3 Empirical methodology

To test the proposed hypotheses, we drew comparisons between the variables that were deemed relevant for each. We calculated and used easy to interpret variables so that they could provide to decision-making management. As shall now be seen, many of these are required for efficient resource management based on sustainability. We now set out the comparative methodology put forward for each hypothesis. In this case, the statistical methodology applied is based on the calculation

of descriptive statistics of the selected economic indicators as averages (simple or weighted) or percentages, with their corresponding dispersion measures. Due to the objectives to be achieved with the present study, we believe that this way of proceeding is more appropriate than the application of statistical inference methods. First, the data are easier to interpret by the different stakeholders when making decisions. Secondly, we believe that the large sample size makes the results obtained generalizable and extrapolable. In addition, the absence of socioeconomic variables in the sample (law enforcement controls) makes the application of this type of technique difficult, as well as not responding to the characteristics and focusing of the study.

When testing the first hypothesis –competition for picking– using the information relevant to this study, we first calculated the weight of each species collected and its relative importance depending on the type of picker (Appendix Table A1). Taking into account the aims of the present study, we distinguished between three kinds of pickers depending on their origin. The first group (Type A) were local pickers, in other words pickers whose residence was in one of the villages located inside the picking area. In addition, the sample used offers no distinction in terms of pickers with regard to what the harvest will be used for (sale or self-consumption) or their motivations for picking, such that it was decided to divide the remaining pickers into a further two groups depending on their place of origin. According to government reports, there is a strong link between this origin and the type of picker (Martínez-Peña, 2015). The second group were therefore (Type B) other national pickers, or pickers who lived elsewhere in Spain, assuming that these pickers are driven by a strong recreational motive. This group could include those pickers that we have previously called mycotourists. These types of collectors would have different motives and motivations than those who only collect for self-consumption (Latorre et al., 2021), but the current system of permit sales does not allow them to be discriminated from the rest. The final group was (Type C) or intensive pickers, or people who lived abroad, assuming that the vast majority of these pickers travel in groups from Eastern European countries due to economic needs in to engage in intensive picking for commercial purposes. This classification criterion sought to distinguish various picker profiles, in line with previous studies which have evidenced the link between the origin of the picker and the final use made of what they pick, differentiating between selling or self-consumption and other motivations such as recreation, as set out in the previous section (Regional Government of Castilla y León, 2006).

Secondly, with regard to testing the second hypothesis –substitution effect between picking and other production activities– we calculated a productivity indicator during the days of picking; specifically, the number of kilograms picked per hour for each of the species and selected picker profiles, together with total productivity (Appendix Table A2). All of this was computed in kilograms per hour dedicated to picking. This enabled us to check for possible differences in the picking habits and skills of each of the chosen picker profiles.

Using these data, we calculated the productivity value during the days spent picking in terms of the prices obtained when selling the species present in the basket (Appendix Table A2). To do this, we employed data on prices paid to commercial pickers for the various species in the transactions undertaken in the woodlands themselves using information from a range of sources, such as surveys carried out among pickers, prices quoted by local businesses or expert opinion (Regional Government of Castilla y León, 2006; Martínez-Peña, 2015). Table 1 sums up this information, and shows the source, number of observations in the study, the place and how the area under study has been stratified, the method used to calculate prices and the price paid to the picker (euros per kilogram) for each species studied. Given the similarity and stability over time of the mean values estimated for prices, we decided to use data corresponding to the study area, attributing it to 2013 and 2014.

This enabled us to make the corresponding comparisons, in terms of opportunity cost, with various types of hourly wages so as to posit what possible effect picking might have on the decisions made by each type of picker (Appendix Table A3 and Figure 2). To do this, we selected various values of hourly wages paid by employers depending on different kinds of labor contract. This allowed us to study the decisions made by the various groups between picking or other activities, such as work and leisure. First, for the lower substitutability limit between picking and other paid activities, we selected the effective minimum legal hourly wage in Spain (W_{min}). Second, as a substitutability option between time spent picking and time spent working, we applied the part-time wage paid per hour at a regional scale, taking into account that more or fewer hours can be devoted to the two activities depending on the remuneration obtained (W_{pt}). To analyze the incentive to quit work to go picking, depending on how easy it is to do so (in other words, temporary employment versus permanent employment), we distinguished this wage in terms of whether the labor contract was temporary ($W_{pt\text{-}t}$) or permanent ($W_{pt\text{-}p}$), bearing in mind that giving up their job has greater implications for the latter group in an economy such as Spain's, which has a high rate of unemployment. Moreover, it is easier to give up temporary jobs during the picking season and then take them up again once the season is over. Third, and as the upper limit without the substitutability option, we took full time wages paid at a regional level (W_{ft}), considering that there are additional determining factors which impact the decision to quit this kind of work and that would already be included in wages, which are already higher. For the same reasons, we also distinguished between wages paid in temporary and in permanent contracts ($W_{ft\text{-}t}$ and $W_{ft\text{-}p}$). As a substitutability option between picking time and leisure time, or recreational opportunity cost, we took 50% of the hourly wage, as has also been done in the relevant literature (W^r) (Parsons, 2003). This wage was calculated for all the hourly wage options proposed and was used to determine the incentive to devote leisure time to picking for each type of contract, such as taking advantage of holiday periods during the mycological season. For all of these variables to have a time correspondence with the data taken from the controls, they were estimated for the fourth quarter of the years studied using the data obtained from the National Statistics Institute. Finally, to examine what incentives drive type C pickers to take the decision to travel to these picking areas from their countries of origin, we took as a reference the mean wage per hour paid in the principal countries of origin (W_i), taken from Eurostat statistics.

In addition, to ensure that the comparisons drawn were similar, wages were estimated in net terms or in the amount to be paid; in other words, once workers' social security or national insurance as well as personal income tax payments had been deducted, following the Spanish tax agency simulation method. This was done because

10.3389/fsufs.2024.1474624

TABLE 1 Prices (in euros per kilogram) of wild edible mushrooms paid in Spain to commercial pickers of the main species of wild edible mushrooms of socioeconomic interest: reference studies.

Source	*n*	Study site	Stratified sampling	Methodology	*Lactarius deliciosus*	*Boletus edulis*	*Pleurotus eryngii*	*Amanita caesarea*	*Cantharellus cibarius*	*Other species*
Regional Government of Castile and León (2006)	1,081	Castile and León (Spain)	44 counties	Weighted average (30% outstanding quality)	3.01	3.85	4.92	4.22	7.00	4.37
Martínez Peña et al. (2015)	4,118	Andalusia (Spain)	36 according to provinces, forested areas and population density	Weighted average/other imputations (local auction/expert opinions/other studies)	2.67	4.85	4.64	4.81	11.39	2.75
Regional Government of Aragón (2019)	265	Teruel (Spain)	6 Counties	Simple mean/expert opinions	3.00	3.90	3.52	4.50	-	11.53

what is harvested tends to be sold in local markets without any taxes being paid or fiscal controls being applied. As a result, it tends to be an opaque market where the returns obtained may be considered in net terms (de Frutos Madrazo et al., 2008). For W_i, the value is considered in gross terms since fiscal pressure is not the same in all countries.

4 Results and discussion

Table 2 shows, in the first column, information related to the definition of each of the indicators, as well as the way in which it was calculated, together with their corresponding units of measurement (column 2), together with their principal descriptive statistics (following columns).

As regards the testing of the first hypothesis (competition for picking), the results of mushroom picking for the years studied are found in Appendix Table A1.

The mean weight of the baskets controlled was between four and five kilograms but there were substantial differences in terms of type of picker. Paradoxically, the lowest weights were recorded among local pickers, since local pickers (type A) might, on average, be expected to display greater picking performance, given their better knowledge of the production areas and their experience. In fact, this proved to be very similar to pickers from the rest of the country (type B). The most striking result is related to the amount picked by the intensive pickers (type C), where the weight per basket, depending on the year, is between four and eight times greater than other pickers. Virtually all of these pickers were from eastern European countries (99.5%), particularly Romania and, to a lesser extent, Bulgaria. Although in percentage terms, type C account for between 2 and 5% of the total number of pickers, they exert an important influence on the socio-economic context. They tend to go picking in larger groups and work as perfectly organized units. In regulated areas, they tend to pick without a permit, as was found to be the case in half of the inspections carried out among them. They are also responsible for 40% of all the violations reported by forest rangers for illegal picking practices, and which entail the national law enforcement authorities requisitioning several tons of wild edible mushrooms every season and even, in many instances, the vehicles used to reach the forest.

As regards the species harvested, local pickers' (type A) baskets tend to contain much the same as those of pickers from the rest of the country (type B). The main species harvested is Lactarius deliciosus, which accounts for over half of the total. The second most important species is Boletus edulis, which represents over a third of the total. The remaining species are found to a much lesser extent, with Pleurotus eryngii being the third species in terms of importance, albeit some way off from the rest. The variety of species picked does, however, tend to be slightly wider in the case of local pickers. This might be due to the longer-running tradition of picking mushrooms which stems from a deeper knowledge of the wide range of species that can be picked for sale and self-consumption. One finding which proves particularly striking is the fact that in none of the checks carried out among type C pickers were any species found other than the two most commercially important. For example, in 2013 the baskets contained virtually only Lactarius deliciosus, the most widely commercialized in terms of volume throughout Spain, both in the domestic market as

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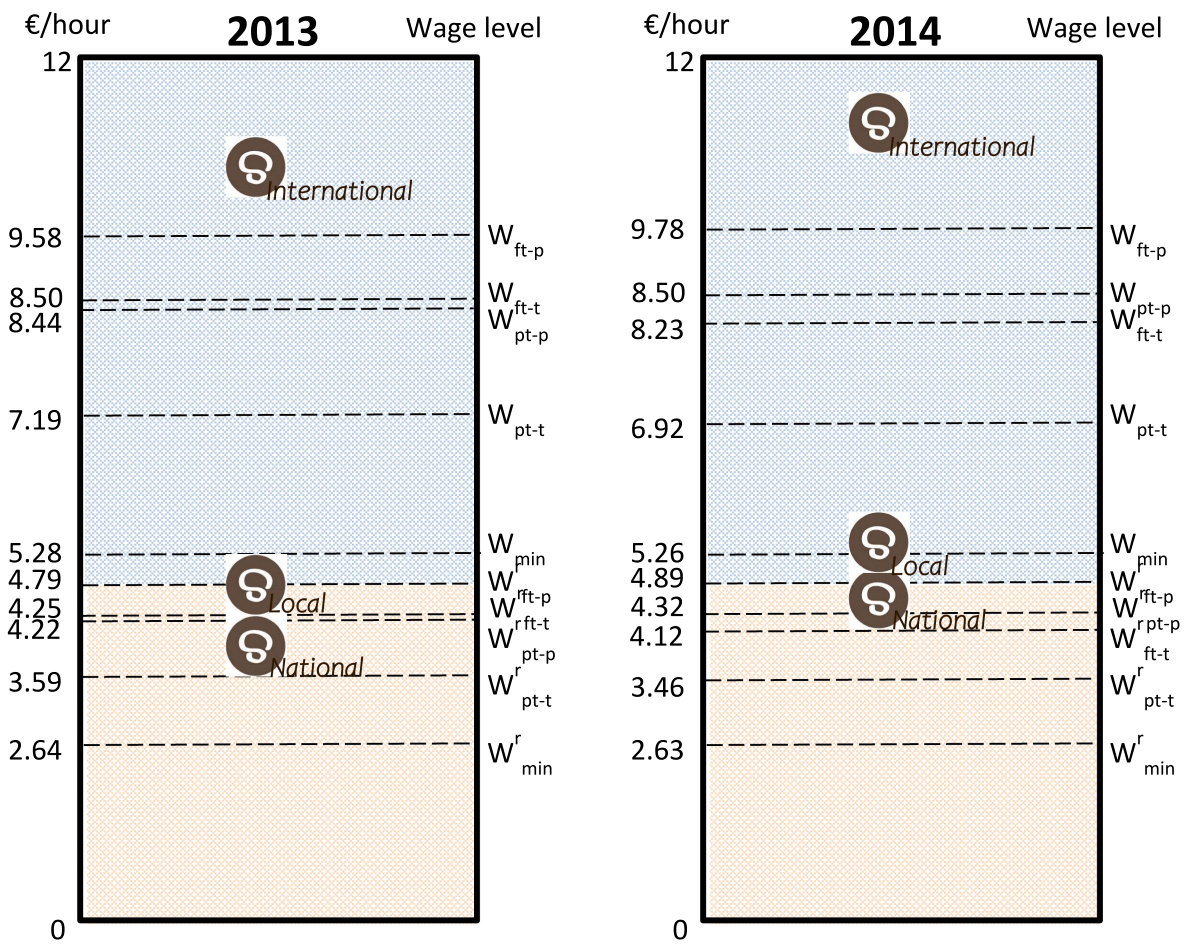

FIGURE 2
Productivity value of the wild edible mushroom yield and wages: 2013–2014.

well as in international transactions (Voces et al., 2012). In contrast, a broad range was found among those who did pick these other species, which gives rise to wide confidence intervals in the measures estimated. This also occurs when estimating the productivity measures presented below.

Perhaps the most significant finding is the high productivity per hour shown by type C pickers. This particular group is able to pick over three times more per hour than the rest. A number of factors might explain this. Firstly, this group come mainly from the Rumanian region of Transylvania, which also boasts a long-standing tradition of picking some of the species studied, such as Boletus edulis (Lovric et al., 2020). These pickers thus take advantage of the fact that the mushroom season has just finished (late August) in their home regions to continue picking in Spain, where the season is just beginning. They might be seen as possessing a certain accumulated know-how regarding the amount of time they have already spent picking compared to local and national pickers. Coupled with the high level of organization found among the groups who go picking, this might give them a certain advantage over national and even local pickers.

Local pickers (type A) display slightly higher returns than other domestic pickers, with the figure being approximately 20% higher. In this case, local knowledge of the areas where mushrooms are more likely to be found (known as "setales" in local jargon) coupled with greater practice based on family tradition would account for this difference. As regards testing the second hypothesis (substitution effect between picking and other production activities), we now present the link between the productivity results obtained per hour of picking and the quantification in monetary terms (Appendix Table A3) together with a comparison to the various wage levels chosen as a reference for decision making on the part of the various types of pickers (Appendix Table A3 and Figure 2). The left-hand side of Appendix Table A3 shows wage level values ordered differentiated by types (recreational as opposed to non-recreational wages). The right-hand side shows the estimated productivity value measured by type of picker, including the upper and lower limits. The central columns thus offer information concerning which place each value of estimated productivity occupies in relation to the corresponding wage value.

As regards the productivity value, the most striking result is the high returns obtained by the intensive pickers (Type C) when selling the collected mushrooms in local markets. This is far in excess of the reference wages in the domestic labor market (see Figure 2). The incentive over the expected return for this group is strong, as is the

10.3389/fsufs.2024.1474624

wage difference between the countries, even when comparing between gross and net terms. The mean gross wage per hour in these countries is below the national net minimum wage. This provides a strong incentive for this type of picker when deciding whether or not to travel to go picking. This group are expected to make around four times more by picking in these areas than they would make in any other job in their home country. Picking in these areas would enable them to obtain an even higher income compared to the mean expected income in their places of origin. This distorts the host country labor market, since they tend to act without a labor contract, have problems obtaining temporary residence, and often illegally sleep overnight in the picking areas. Also evident is the weight of the Lactarius deliciosus as the most socio-economically important species (Román and Boa, 2006; Voces et al., 2012) and the one most able to generate income among all the groups (Appendix Table A1). The fact that virtually the whole of this group's harvest is of this species supports this idea. Intensive pickers (type C) are thus focusing their efforts on the species which will bring them the greatest return. This finding is similar to the results reported by authors in other countries, where there tends to be one species which stands out over the rest due to its ability to generate greater value (He et al., 2011; Thapa et al., 2014; Hassan Sher et al., 2015; Zulu et al., 2019).

In contrast, quite the opposite is to be found among national pickers (Type B), where the recreational element would seem to prevail, as is supported by studies on the issue (de Frutos Madrazo et al., 2012; Büntgen et al., 2017). For many of the recreational wages in 2013, as well as some in 2014, it is not worth dedicating the time to picking in the hope of a return that will compensate for the recreational time devoted. In other words, the time devoted to picking would be generating satisfaction, which is why people engage in this kind of activity (de Frutos Madrazo et al., 2019). For this particular group, the estimated values depend to a large degree on how good the mushroom season is, which might make them indifferent toward either selling their yield or not for most of the wages in the leisure area, as is the case for 2014. As regards local pickers (type A), in all cases it is worth their while devoting their leisure time to picking and to becoming commercial pickers. Wild edible mushrooms may thus be considered as a complementary source of income for local communities (Manna and Roy, 2014; Ei et al., 2019). These contributions to the family budget could be provided by any member of the household (Cai et al., 2011). Even if they were working, it would still be worth their while devoting time to picking. Since they account for over half the total number of pickers (Table 2), the positive effect is that this group would be ensuring that the products entered the commercial chain (Montoya et al., 2008) and that they would be reaching end consumers. Moreover, there would also be the incentive to leave low quality jobs that paid the minimum wage, such that picking wild edible mushrooms would help to dignify the local population, since they would not be forced to accept precarious jobs and would be able to replace them with traditional activities linked to their environment (Yilmaz and Zencirci, 2016). In turn, another positive effect for local workers would be the trend toward higher wages in the picking areas.

Finally, the estimated data fail to support the second hypothesis in the study (existence of a substitution effect between picking and other production activities). For the 2 years estimated, the productivity value of picking wild edible mushrooms obtained by the local

TABLE 2 Principal statistics of the variables used.

Definition	Units	*N*		Mean		SD		Min		Max	
		2013	2014	2013	2014	2013	2014	2013	2014	2013	2014
Weight of the controlled basket of each one of the species.	Kg	1,533	3,244	4.18	4.83	7.88	8.37	0	0	170	112
Number of pickers who share a basket when picking.	Pickers	1,533	3,244	1.53	1.4	0.94	0.85	1	1	10	10
Percentage of pickers who had not picked anything when the control was carried out.	%	1,533	3,244	4.94	4.8	-	-	-	-	-	-
Mean weight picked for each of the hours until the moment the control was carried out.	Kg per hour	1,533	3,244	1.31	1.54	1.47	1.7	0	0	13.5	21.6
Mean value of the harvest for each of the hours until the moment the control was carried out.	€ per hour	1,533	3,244	4.53	5.32	5.08	5.87	0	0	39.02	62.42

population does not appear to have any impact on the labor relations between employer and employee, as it is well below all the estimated wage values.

5 Conclusion

This work presents picking yields (in kilograms per hour) for three characteristic mushroom picker types and for two of the most traded wild edible mushroom species groups in Europe, Boletus edulis and Lactarius deliciosus. These harvesting yields are estimated from a robust and reliable database and can be representative of harvesting yields in coniferous forests (*Pinus sylvestris* and *Pinus pinaster* in south-west Europe).

The present study addresses two problems: firstly, the effects triggered by competition for picking wild edible mushrooms, and secondly what impact this activity can have on the labor market. As regards the first hypothesis (competition for picking), the principal conclusion to emerge is that the negative effects of mushroom picking may be considered internal and would be more closely linked to competition for picking and not so much related to possible adverse effects on other activities, such as unwanted effects on the local labor market. In other words, such effects are likely to appear during the activity itself. Problems between the various commercial pickers, depending on where they are from, as well as between commercial and recreational pickers, are likely to increase, given that wild edible mushrooms are a resource which is finite and limited due to environmental and climatological conditions.

In the first case, regulation should continue to prioritize local commercial picking over that undertaken by outsiders. The strong element of public ownership (municipal and regional) over woodland should ensure the income of the local population as opposed to that of other groups. As a result, regulation based on picking permits for commercial purposes that gives preference to local interests should be extended to all of the areas where wild edible mushrooms are to be found. This measure should go hand in hand with greater supervision on the part of the law enforcement authorities, since there is an enormous income incentive to break the law which it will prove extremely difficult to eradicate despite the existence of deterrents. If this increase in intervention is to be justified, fresh studies are required to evidence the harmful effects of illegal picking on the sustainability of the resource in question.

In the second case, the solution put forward does not seem to be so straightforward. Even though current regulation also prioritizes local picking over recreational picking, said difference does not appear to be so important. It is difficult to predict what effects controlling the yield of this type of recreational picker might have on the area's economic activity. Mycotourism's impact on the hotel and catering industry has been amply demonstrated and its potential spillover effect on the local economy might prove to be more important than that to emerge from selling the yield in the local markets. Further studies are required to test this hypothesis and to put forward the necessary measures. Whatever the case, given the coexistence of the two models in woodlands in similar proportions, fresh inquiry should be undertaken focusing on the link between general access to wild edible mushrooms and the sustainability thereof.

As regards testing the second hypothesis (substitution effect between picking and other production activities), to conclude, what might be termed the external effects of picking and, specifically, those which impact the labor market, do not appear to be so important, and if they do exist it would seem that the positive effects outweigh the negative ones. There seems to be a greater incentive to devote leisure time to mushroom picking, such that the hypothesis of substitutability between leisure time and picking does appear to be evidenced, although the same cannot be said between worktime and picking. As a result, the negative effects would only be occasional specific problems suffered by certain local firms in which workers might try to concentrate their holiday periods during the picking season for the vast majority of labor contracts.

Finally, we would like to point out that the impossibility of testing this second hypothesis could perhaps be related to the way in which the salary levels of the different countries have been selected, since, the differences in wage levels can be attributed to different factors like national wage regulations, market labor imperfections, different levels in socioeconomic development cross-country and so on. Further research related to the socioeconomic characteristics of foreign pickers in relation to nationals would be desirable to be able to state more precisely that these wage differences are not generating distortions in the way in which the regulation system through the sale of permits discriminates between the different types of them.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Author contributions

PF: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. JL: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. PM-C: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing. FM: Conceptualization, Data curation, Formal analysis, Funding acquisition, Investigation, Methodology, Project administration, Resources, Software, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2024.1474624/full#supplementary-material

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