

Article

Greece's Forest Sector from the Perspective of Timber Production: Evolution or Decline?

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Abstract: Greece's trade patterns in wood and wood products align with the broader trade dynamics in the Mediterranean region, where wood and wood products are primarily imported. Using Pettitt's test, this study revealed a consistent decline in the production of selected wood and wood product categories in Greece, coupled with a noteworthy increase in imports. Following the economic crisis of 2008, a temporary dip in import trends in some categories was observed. Furthermore, Pettitt's test helped identify the specific years when significant shifts occurred in the time series data. In the latter part of the analysis, the study underscored the significance of various factors within the wood removal production sector, including urbanization, economic growth, personal income, and the labor force. National imports of goods and wood fuel were also identified as playing pivotal roles at the national level. Recognizing the link between economic indicators and wood removals has the potential to inform decisions related to sustainable resource management, conservation initiatives, and strategies for economic development.

Keywords: forest sector; socioeconomics; Pettitt test; wood production; Greece



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1. Introduction

Forests can serve as a source of renewable energy through biomass utilization, including wood pellets, chips, and bioenergy production [1,2]. In this framework, the forest sector has been defined to cover both forest resources and the production, trade, and consumption of forest products and services [3] (FAO, 2005). The bioeconomy, which encompasses various sectors utilizing biological resources, can derive value from forest-based industries such as pulp and paper, biofuels, and biochemicals [4–6]. Particularly in Greece, where the forests do not yield significant quantities of timber through direct or quantitative means [7], the various other aspects of forest utilization have gained paramount importance for the national economy [8,9]. Consequently, the forest sector is crucial in generating employment opportunities, especially in rural areas where alternative job prospects are often limited [10–12]. Activities such as forest management [13–15], logging operations [16], forest restoration, and related endeavors [17–19] not only have the potential to create jobs but also to enhance livelihoods and contribute to the growth of local economies.

Forest planning and management operate centrally at the national level, overseen by the Ministry of Environment through its General Secretariat of Forest and National Environment. Regionally, state forest districts (~66% of the total), led by Forest Directorates or Forest District Offices, hold real power and responsibility for implementing management plans. The Forest Service manages state-owned forests and approves plans for privately owned forests, ensuring comprehensive consideration of environmental, ecological, socio-economic, and productive factors [20].

Regarding Greece's forested areas and wooded lands, the total stem volume of living trees, or growing stock, amounts to 193 million cubic meters. Within this figure, approximately 83 million cubic meters consist of coniferous trees, while the remaining portion

comprises broadleaved trees (this excludes shrub volume) [21]. The accumulation of growing stock in Mediterranean forests can be attributed to many complex factors, each with varying levels of significance [22,23]. The combined impacts of heightened CO₂ concentrations and nitrogen deposition can lead to accelerated growth rates [24,25]. Additionally, the relatively low levels of harvesting activity compared to growth might be attributed to factors such as prevailing market conditions, increased societal recognition of the multifunctional role of forests [26,27], and improved forest management practices geared towards the optimal and sustainable development of the goods and services furnished by forest ecosystems [28,29].

A distinctive feature of Greece's landscape is that a substantial portion of its forested areas are situated in regions characterized by steep mountains and slopes [30]. Consequently, the harvesting processes in these areas often prove to be exceedingly challenging [31]. Furthermore, the production of wood and the resulting quality frequently face limitations due to a variety of managerial and ecological factors. These factors include the presence of numerous knots, defects in tree trunks, and small timber sizes [32].

According to Koulelis [33], Greece ranks among the European Union (EU) countries with low productivity in terms of wood output. The removal of wood resources at the national level is affected by a range of adverse factors. These encompass issues related to organization, such as complex harvesting procedures, as well as inadequate financial support for forest management plans. Ambiguities regarding forest land ownership, conflicts with forest-related regulations, governance challenges, bureaucratic obstacles, instances of illegal logging, and generally ineffective national forest policies all contribute to the difficulties in this domain. Greece's forest sector has long grappled with a trade deficit in forest products, which intensified during the euro years. In addition, the annual trade deficit soared from EUR 25 billion before the euro era to EUR 33 billion from 2002–2014, peaking at EUR 44 billion in the pre-crisis years (2006–2008) [33].

The forest products trade deficit contributed significantly to this imbalance, consistently growing over time. In 2008, Greece's forest products trade deficit reached USD 1.2 billion, contrasting with USD 293 million in the 1980s and USD 778 million in the 1990s [34,35]. The financial crisis hit the national forest sector hard, causing a steep drop in roundwood consumption, with a 36.6% decline in 2008. Although a partial recovery occurred by 2012, a subsequent significant decline resulted in a total 20.6% reduction. This downturn affected sawnwood and wood-based panel consumption as well, which plummeted by 50.8% and 83.6%, respectively (ibid).

Greece's efforts to boost domestic timber production through small sawmills helped cushion the sector's impact on unemployment and local communities. However, the broader industry faced a 7.9% value decline from 2008 to 2011, translating to EUR 1.44 billion, and lost 37% of its workforce, around 200,000 jobs [36]. In the midst of these challenges, per capita fuelwood consumption increased by 17.2%, driven by rising oil prices and economic uncertainty, leading many to turn to renewable energy sources (RESs) for energy needs [37,38]. The limited literature available offers a set of strategic actions that target the situation described above. Boosting domestic production across various product categories and enhancing marketing efforts would progressively lessen the need for imports [35]. This enhancement, when combined with the establishment of a well-organized structure for small-scale industrial plantations, holds the potential to heighten the competitiveness of domestic roundwood products. Essential measures include safeguarding existing raw material resources, upgrading production infrastructure, cultivating a skilled and cost-efficient workforce, fostering an appealing investment environment, and implementing economic incentives within the primary wood-processing and furniture industry sectors. These actions serve as fundamental prerequisites for advancement. The proposed strategies focus on revitalizing, reinforcing, and fostering connections between forest enterprises and urban and potential foreign partners [35].

Conversely, non-wood forest products (NWFP) and related services could yield opportunities for rural development, given specific conditions and a determined commitment

from local and national authorities [39–41]. The state's role in enhancing the competitiveness of regions remains pivotal. Irrespective of the newfound objectives of the forest strategy, it must account for distinct regional, sectoral, and policy-driven factors to amplify the impact of forest enterprises on both rural and national economies.

The primary objective of this study is to discern the latest production and imports trends across five key wood and wood product categories on a national scale, namely: (1) roundwood, (2) industrial roundwood, (3) sawnwood, (4) wood-based panels, and (5) paper and paperboard. By analyzing the uniformity in mean production and import quantities within these main categories utilizing Pettitt's test, we aimed to delve into the state of the national forest sector and to determine whether any changes are occurring during the extended period of consistent decline. Simultaneously, we explored how certain socioeconomic variables can influence wood removal production, aiming to uncover the primary reasons behind the observed decline in the forest sector.

2. Materials and Methods

To investigate significant changes in production trend width over the years, we chose to implement the Pettitt homogeneity test [42] using time series data from the Statistics Division of the Food and Agriculture Organization of the United Nations (FAOSTAT UN, period from 1990 to 2021) [43]. In general, homogeneity tests involve a large number of tests for which the null hypothesis is that a time series is homogenous between two given times. Pettitt's test is a non-parametric test that requires no assumption about the distribution of data. It is an adaptation of the rank-based Mann–Whitney test that enables identification of the time at which one statistically important (p value) in a time series shifts.

The Pettitt test was selected as the methodology for identifying any inconsistencies in the analyzed time series within this research. This non-parametric approach to change-point analysis, proposed by Pettitt in 1979 [42], remains widely adopted. The test identifies shifts in averages and gauges their statistical importance through hypothesis testing [44]. The null hypothesis posits data homogeneity, while the alternative suggests a change in the data at a certain point. The empirical significance level (p -value) was computed using XLSTAT 2018v.5. Although the Pettitt test is not commonly used in socioeconomic studies, the existing literature has applied this method to detect change points. For instance, Vilasuso [45] utilized the Pettitt test, along with other non-parametric change-point tests, to analyze data related to the duration of business cycles in the United States. Additionally, Joo Oh [46] employed this non-parametric test to examine stock price index values, aiming to analyze stock market tick data using a nonlinear model. Furthermore, the same author compared three different change-point detection methods when investigating the Korean economic crisis of 1997. The results indicated that the Pettitt test outperformed the other methods [47].

3. Results

The results are presented in two sections as follows. First, the Pettitt test is conducted at a significance level of 5% using time series quantity data for five wood product categories. The primary goal of this test is to identify shifts in the average and determine their statistical significance through hypothesis testing.

In the second phase of the analysis, we examine the statistical relationship and significance of six socioeconomic variables (namely, gross domestic product (GDP), GDP per capita, urban population, imports of goods, sector employment, and wood fuel imports) from various international databases [48–52]. These variables correlated with national wood removal data, encompassing all types of wood extracted from forests and sourced from FAOSTAT (the analysis did not account for inflation as a constraint in completing the specific analysis) [43]. The objective was to investigate how these socioeconomic factors are related to and influence wood production.

3.1. Finding Break Years in Trends with Significant Changes

Notably, the test shows a statistically significant downward trend in production across all categories and no upward trend, starting with roundwood in 2004 and sawnwood in 2005. Additionally, industrial roundwood, wood-based panels, and paper and paperboard production began to decline significantly after 2008 and 2011, respectively. Since then, there have been no signs of an upward change. Figures 1–5 and Table 1, clearly illustrate that production values in most categories have declined by approximately 40% to 50%. For instance, roundwood production, encompassing all wood obtained from various sources, including forests and trees outside forests, as well as wood recovered from natural felling and logging losses during a forest year, decreased from an average of 2 million cubic meters to 1.5 million cubic meters during the studied period.

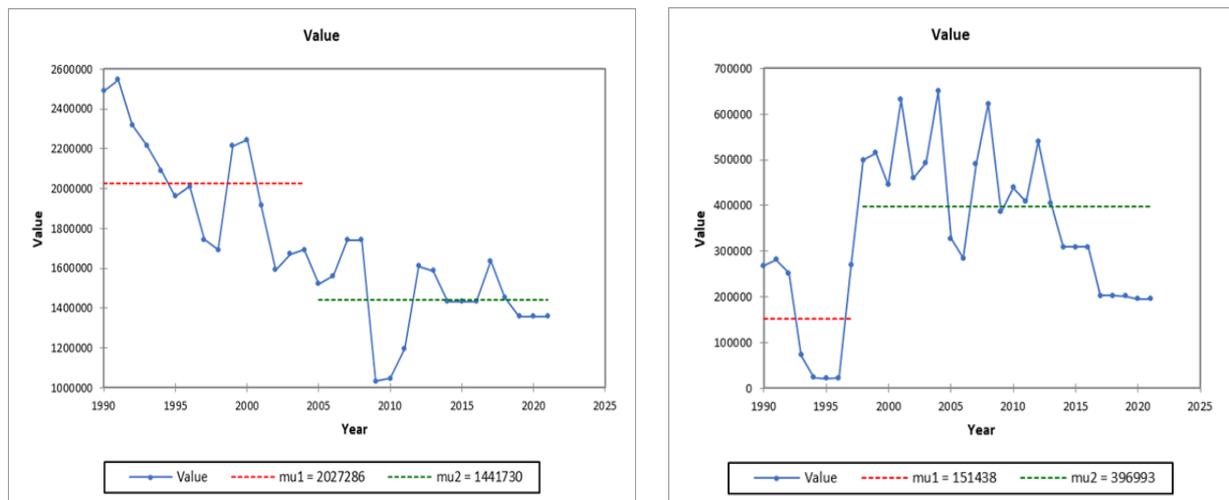


Figure 1. The significant break point (2004) and downward shift in roundwood production (left) and break point (1997) and upward shift in imports (right), according to the annual mean over the last decades, determined using the Pettitt homogeneity test ($p < 0.001$).

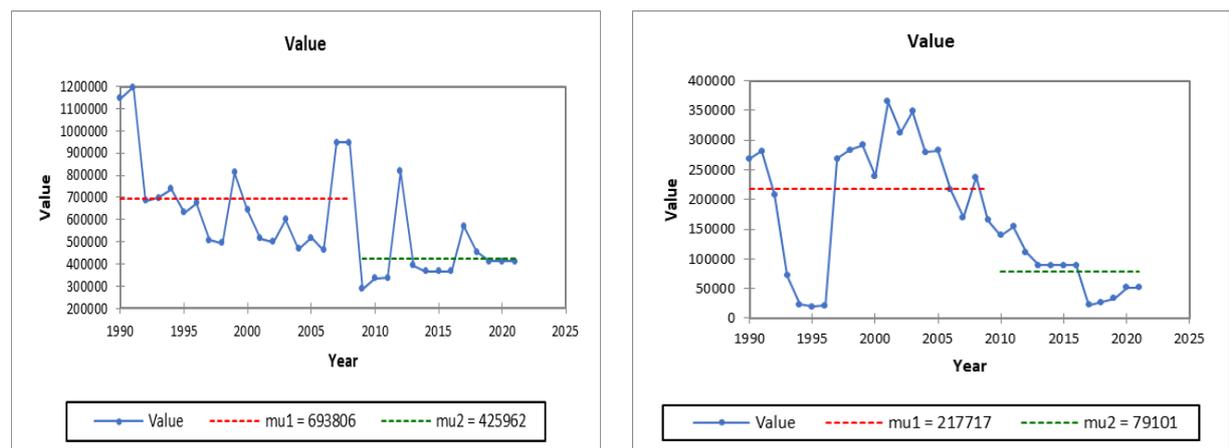


Figure 2. The significant break point (2008) and downward shift in industrial roundwood production (left) and break point (2008) and downward shift in imports (right), according to the annual mean over the last decades, determined using the Pettitt homogeneity test ($p < 0.001$).

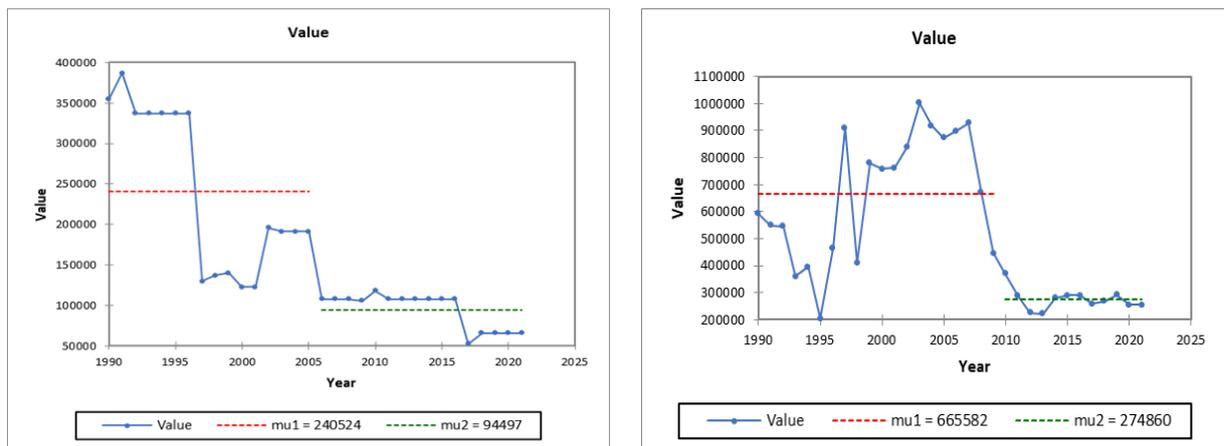


Figure 3. The significant break point (2005) and downward shift in sawnwood production (left) and break point (2009) and downward shift in imports (right), according to the annual mean over the last decades, determined using the Pettitt homogeneity test ($p < 0.001$).

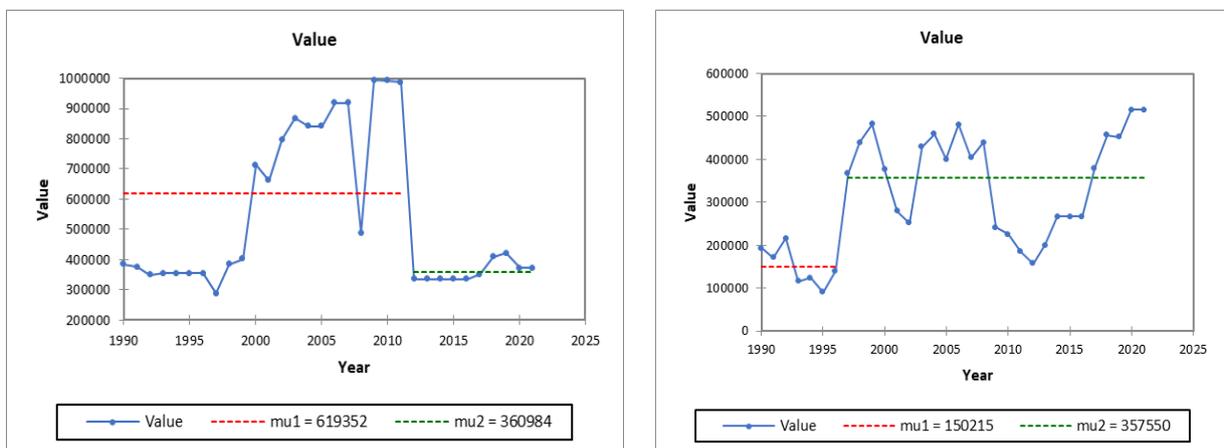


Figure 4. The significant break point (2011) and downward shift in wood-based panels production (left) and break point (1996) and upward shift in imports (right), according to the annual mean over the last decades, determined using the Pettitt homogeneity test ($p < 0.001$).

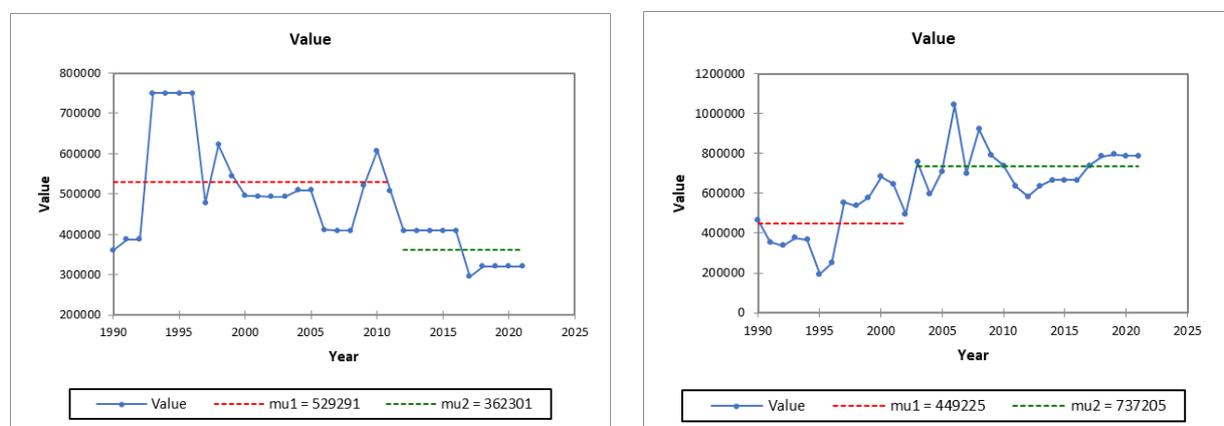


Figure 5. The significant break point (2011) and downward shift in paper and paperboard production (left) and break point (2002) and upward shift in imports (right), according to the annual mean over the last decades, determined using the Pettitt homogeneity test ($p < 0.001$).

Table 1. The results of the Pettitt homogeneity test and the statistically significant change years regarding the production/imports of the selected wood product categories.

Category	Change Point at Year	Two-Tailed Test (<i>p</i> Value)	Shift
	Production/Imports	Production/Imports	Production/Imports
Roundwood	2004/1997	<0.0001/0.014	Downward/Upward
Industrial roundwood	2008/2009	<0.0001/0.0107	Downward/Downward
Sawnwood production	2005/2009	<0.0001/<0.0001	Downward/Downward
Wood-based panels	2011/1996	0.027/0.006	Downward/Upward
Paper and paperboard production	2011/2002	0.001/<0.0001	Downward/Upward

Similarly, industrial production dropped from almost 700,000 cubic meters to 425,962 cubic meters after 2008. As expected, sawnwood production also fell sharply to an average of 94,497 cubic meters after 2009, compared to an average of 240,524 cubic meters before that time. It is worth noting that sawnwood values include both domestically produced and imported roundwood [53], indicating a decline in national industry productivity, likely due to reduced demand.

Furthermore, wood-based panels, including veneer sheets, plywood, particle board, and fiberboard, exhibited an average decline of 258,368 cubic meters, while paper and paperboard production saw an average decline of 166,990 tons after 2011. Considering that these categories represent a significant portion of national timber production and that these downward trends have persisted for extended periods (e.g., 22 years for roundwood and 18 years for sawnwood), it is crucial to emphasize that there are currently no signs of a reversal in these trends. The decline appears to be ongoing and seemingly perpetual.

The analysis of imports, considering the same categories, paints a different picture. With the exception of industrial roundwood and sawnwood, most categories show an increase in quantity values after the break years. Roundwood imports, on average, have risen to 396,993 cubic meters from 151,438 cubic meters prior to 1997, indicating a potential surge in demand for wood and increased consumption. However, this increase seems to have tapered off after 2012 (see Figure 1, right), returning to levels reminiscent of the pre-1997 period. It's important to note that this decline continues through the most recent study years. This decline is likely the factor behind the significant decrease in imports of industrial roundwood after 2009 (Figure 2, right). In this case, the time frame is sufficiently large to be detected by the test, revealing reduced demand for the product during the national economic crisis post 2008 [35].

As anticipated, sawnwood imports also exhibit a decline, reaching an annual average of 274,860 cubic meters from 665,582 cubic meters before the pivotal year, 2009. Conversely, panel imports show a substantial increase after 1996, following the pattern of roundwood, rising to 357,550 cubic meters from 150,215 cubic meters before the break year. However, this increasing trend experienced an internal dip after 2008, lasting until 2012, at which point a resurgence began. Notably, the values for 2019 and 2020 reached levels surpassing half a million cubic meters.

Lastly, paper and paperboard imports have increased from an average of 449,225 tons to 737,202 tons after the break year, 2002. The crisis-related decline [35], observed in the previous categories, appears to manifest after 2008, persisting until 2012 (Figure 5, right). The overall import trend appears to be on the rise, possibly in response to declining production levels to meet consumer demand. Additionally, the demand for timber products, whether domestic or international, remains a pivotal factor. However, it is important to note that economic circumstances, such as the economic crisis that occurred after 2008, have inevitably influenced market demand on a national scale.

3.2. Main Factors Influencing Production

In general, several key factors profoundly affect national timber production. These factors encompass the availability and condition of a country's forested areas. Parameters such as forest size, species diversity, and tree age can significantly influence the overall timber yield [54–56]. Additionally, government policies and regulations, including aspects such as logging permits, land-use regulations, and environmental protection laws, can either bolster or constrain timber production. Economic factors also play a pivotal role in this context. Variables such as labor costs, energy prices, and the periodic conditions of international trade can directly impact the cost dynamics of timber production, the level of technology and infrastructure, the subsequent efficiency of transportation, climate conditions, and the occurrence of natural disasters, shaping the levels of national production [57,58].

The forests in Greece are characterized by pure management, and imports from commercial firms mainly cover the domestic demand. However, this situation contrasts starkly with the ongoing decline in wood production over the past few decades. One significant factor contributing to this decline is undoubtedly the economic crisis that struck Greece after 2008 [59], with severe repercussions for the national GDP, the overall economy, and consumer incomes [60,61]. The financial crisis had a profound impact on Greece's construction industry [62]. As a result, households scaled back their spending by nearly 30% [63], which in turn triggered a sharp decline in the demand for wood and wood products. Despite these economic challenges, Greece has long grappled with a trade balance deficit issue, which intensified during its tenure as a eurozone member [64]. The previously presented trade deficit experienced a rise from its pre-euro average to the euro era (2002–2014) and eventually reached its peak in the three years leading up to the crisis (2006–2008). This deficit extended to the trade of forest products, showing a consistent upward trend over the years. Specifically, following 2001, while the rest of the European Union was reducing deficits in the trade of forest products, Greece's deficit escalated rapidly, reaching \$1.2 billion in 2008. This was a substantial increase from \$293 million in the 1980s and \$778 million in the 1990s [35]. The persistent deficit in forest product trade highlights that Greece continuously imported such products without giving due attention to the potential for domestic exports sourced from its own production.

To address the issue of inefficient production, the “wood removals” (WR) variable was selected, which covers all types of wood extracted from forests, including both roundwood and other woody materials. Addressing this question becomes quite challenging regarding the latter analysis and considering the available data.

Wood removals provide a broader perspective on the utilization and management of forest resources (Figure 6). By definition [53], “wood removals” refers to the total amount of wood resources extracted or removed from forests or wooded areas. This category includes all forms of wood, including roundwood (harvested trees), branches, bark, and even wood recovered from natural losses, such as fallen trees or debris. In addition, it provides a comprehensive view of all wood resources utilized or removed from forests, whether they are intended for industrial purposes or other uses. WR was selected to correlate with specific noteworthy economic and social variables available.

Table 2 illustrates the relationships between the volume of WR and various economic and demographic factors, including GDP, urban population, imports of goods, wood fuel imports, and employment in the mixed sector, which encompasses agriculture, forestry, and fishing. Notably, the urban population, exhibiting a consistent upward trend as depicted in Figure 7 demonstrates the most substantial negative correlation coefficient ($r = -0.867$) with a significance level of $p < 0.001$. Following closely are the economic development indicators, with GDP (Figure 8 upward trends) showing a correlation of $r = -0.825$ and GDP per capita showing $r = -0.818$, with both significant at $p < 0.001$. As anticipated, employment in the mixed sector, which encompasses forestry (data specific to the forest sector alone are unavailable), displays a positive correlation with WR, registering a coefficient of $r = 0.710$ at $p < 0.001$. In contrast, there are weaker negative correlations observed with national-level

imports of goods ($r = -0.492, p < 0.05$), (Figure 9) and wood fuel imports ($r = -0.393, p < 0.05$). It is essential to highlight that imports of roundwood, industrial roundwood, and sawnwood do not exhibit statistically significant correlations.

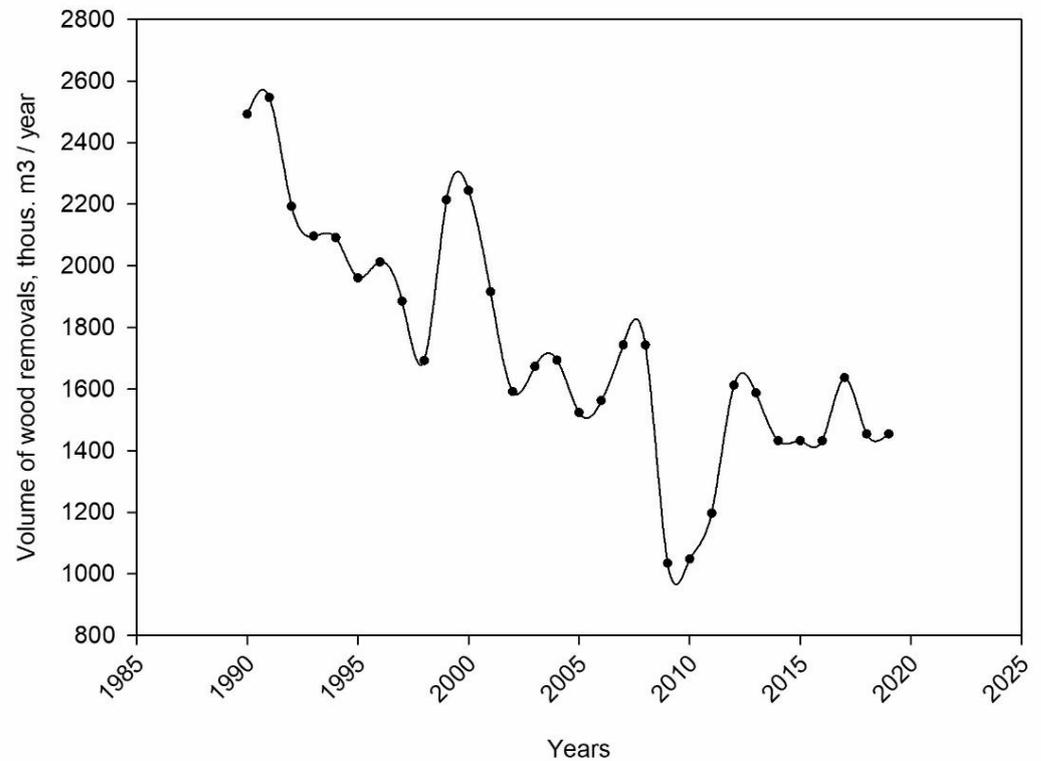


Figure 6. The wood removal volume in Greece during the period from 1990–2021.

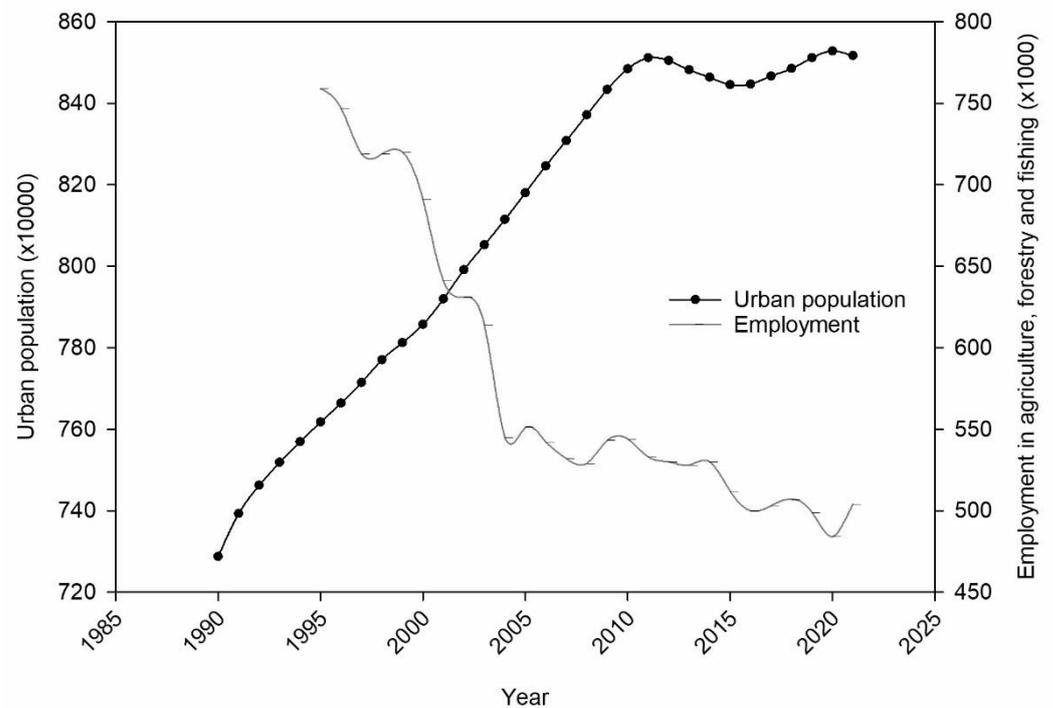


Figure 7. Urban population and employment in the sector for the selected period.

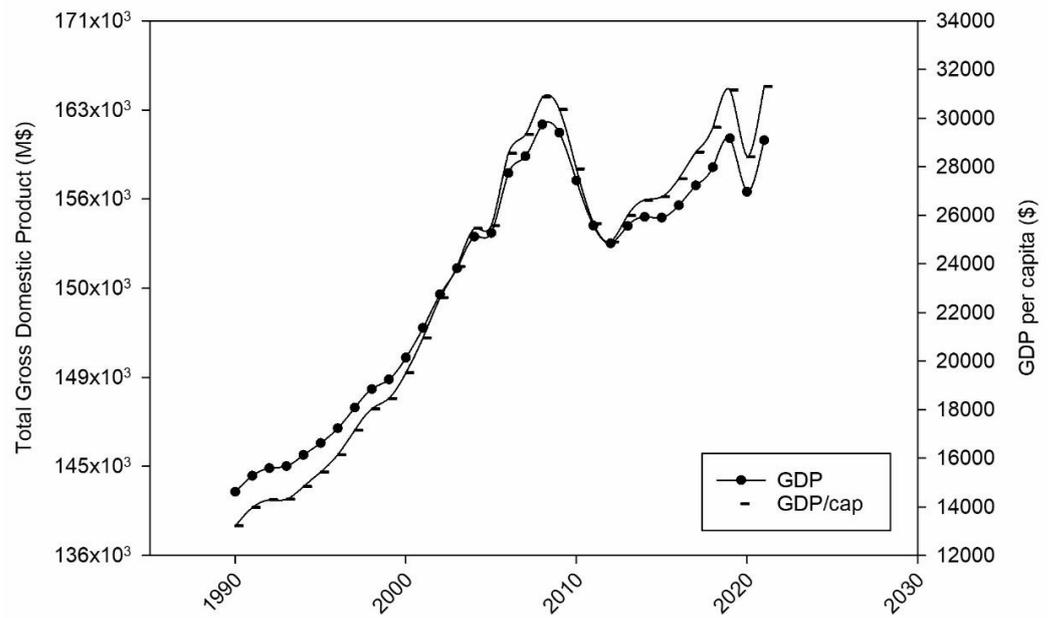


Figure 8. The gross domestic product of Greece during the period from 1990–2021.

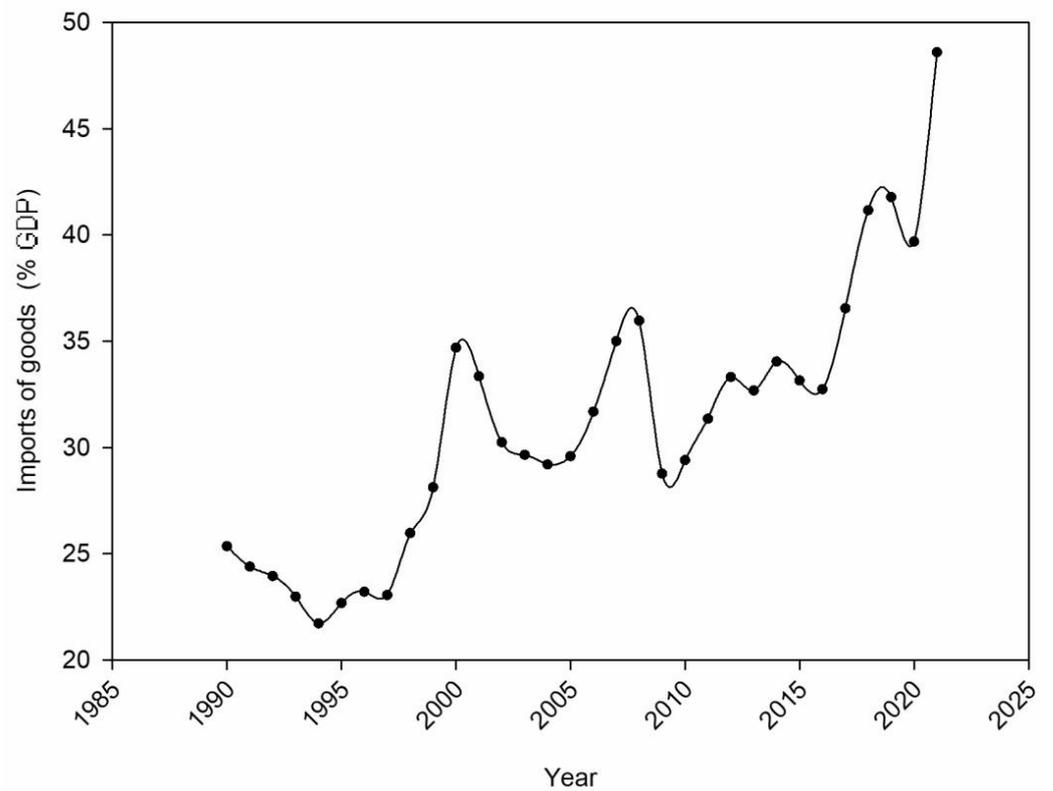


Figure 9. Imports of goods at the national level (% Gross Domestic Product).

Table 2. Correlation results between wood removals and selected economic, trade, and social variables (* $p < 0.05$, ** $p < 0.001$).

Production	GDP ²	GDP/cap ²	UrbPop ³ (M People)	Imports of Goods (% of GDP ⁴)	Sector ⁵ Employment (Thous. People)	Wood Fuel Imports (Total m ³) ⁶
Volume of wood removals (WR) (1000 m ³ /year) ¹	−0.825 **	−0.818 **	−0.867 **	−0.492 *	0.710 **	−0.393 *

¹ WR data were received from UNECE FAOSTAT [43]. ² GDP data were received from the Organization for Economic Co-operation and Development (OECD) database [49]. ³ Urban population was received from the World Bank database [51] and refers to people living in urban areas as defined by national statistical offices. The data were collected and smoothed by the United Nations Population Division. ⁴ Imports of goods % GDP data were received from the OECD database [50] and are defined as the transactions in goods between residents and non-residents. ⁵ Employment data were received from the UNECE Statistical Database [52], compiled from national and international (EUROSTAT, OECD, CIS) official sources. Employment in agriculture, forestry, and fishing was assessed. ⁶ Wood fuel imports data were received from FAOSTAT [43] and refer to “Roundwood that will be used as fuel for purposes such as cooking, heating or power production, it excludes wood charcoal, pellets and other agglomerates”.

4. Discussion

Economic challenges in the aftermath of the global financial crisis led to reduced investment in the forest sector, impacting production capabilities. Additionally, stringent environmental regulations seem to have influenced harvesting and production practices during the last decades, potentially slowing down output. Furthermore, the noticeable rise in imports, as revealed in the results, particularly during the economic recovery period, can be attributed to cost-efficiency considerations and changing consumer preferences for a wider array of wood products. Greece’s trade patterns align with the overall trade situation in the Mediterranean region, where wood and wood products are predominantly imported. Despite the region’s substantial production, these products are primarily directed towards local markets, with trade originating mainly from northern Mediterranean countries in the southern and eastern subregions. Nevertheless, this trade only partially meets the region’s demands, resulting in the Mediterranean region continuing to be a net importer of wood and wood products [1]. The role of consumers in promoting the local supply chain of forest products from legal and sustainable sources could be crucial, since more consumers worldwide tend to prefer sustainable timber products and this attitude affects the governmental policies [65–67]. The presence of negative Pearson correlations among wood removals and economic indicators such as GDP, GDP per capita (widely used in forest sector studies) [20], imports of goods, and wood fuel imports can provide insights into the relationships between these variables. The result of increased efficiency and sustainability in the national use of wood resources may be attributed to several factors, including technological advancements, conservation initiatives, and a shift towards less wood-intensive industries. However, conservation efforts seem to be the most suitable explanation among these factors. Specific challenges have been identified regarding the national forest sector, such as a low level of automation in harvesting, rising transportation costs, and outdated forest management plans, as referenced by Koulelis and Kazana et al. [35,68].

A closer examination of the negative correlation between wood removals and GDP or GDP per capita suggests that with economic growth, there may be a decline in wood removals (Figures 6 and 8) that can be explained by the factors analyzed previously. Nonetheless, it is crucial to take into account that the diminished demand, influenced by factors such as income, as explained by Buongiorno [69], likely plays a significant role in this strong relationship, signifying reduced demand during economic downturns, such as in crisis years. The decline in demand for forest products, in general, was highlighted by Koulelis [35], particularly during the financial crisis period, which witnessed significant losses in the national forest sector. The timber industry, in particular, was severely impacted by a decrease in demand during the economic crisis, primarily after 2008 [59].

Many production and commercial firms suffered substantial losses as they saw a significant reduction in their customer base. The literature proposed that the national forest sector should evolve beyond traditional protection measures and move towards more extensive utilization [70]. This can be achieved through various actions, including limiting the retention of natural forest capital, exploring alternative opportunities for resource utilization, increasing logging activities while adhering to sustainable forest management (SFM) principles, establishing or adopting a national certification scheme, investing in industrial plantations, and ensuring stable prices and raw material quantities from national forest resources over extended periods based on management plans. More specifically, Greece's involvement in an international certification organization and the establishment of a sustainable forest management (SFM) certification system could positively change public and institutional perceptions of forest management, as well-summarized by Georgiadis and Cooper [71]. Certification, aligned with global trends, may become crucial for international timber trade. It can serve as a valuable marketing tool for Greek businesses entering new markets, enhance environmental profiles, and foster broader participation in forest decision-making. SFM certification offers generic advantages, such as monitoring certified areas, ensuring compliance with laws, addressing management shortcomings, and contributing to the country's development.

Furthermore, the negative correlation between wood removals and imports of goods may suggest an increasing dependence on imported goods (Figures 6 and 9), which can lead to reduced levels of domestic wood removal. In essence, consumers' thinking is generally turning to foreign sources not only for goods but for wood-related products as well, instead of relying on domestic resources. This issue is interconnected with the aforementioned observations. Indeed, the levels of wood and wood-related product production alone would never be sufficient to meet domestic demand or significantly boost exports. However, implementing a specific plan that supports production industries and good marketing practices could help reduce the need for extensive imports from commercial firms as much as possible [35].

The negative correlation between urban population growth and wood removals (Figures 6 and 7) underscores a complex interplay between urbanization, economic shifts, and changing lifestyles. People who once resided in forested areas have migrated to cities in search of better life opportunities. This migration away from forests has significant implications for both forest exploitation and protection. Simultaneously, the number of individuals employed in the agricultural sector (forest sector included) appears to have decreased by more than 10% over a 25-year period. This aligns with the observations Tsioras [72] made regarding forest workers in the country. They also expressed the belief that the state lacks adequate interest, and they emphasized income-related problems as the top priority. These findings indicate that the number of forest workers is likely to keep decreasing without specific interventions. Economic factors play a role in determining the size of the forestry workforce. In regions experiencing reduced demand for wood products, the workforce tends to shrink, leading to lower levels of wood removal. A decrease in wood removals may be related to shifting market dynamics, including changes in demand for wood products, international trade patterns, or global economic conditions.

The negative correlation observed between wood removal and wood fuel imports suggests that consumers are potentially meeting their energy needs through imports. It is important to emphasize that wood fuels generally hold significance in the Mediterranean region. However, quantifying their production and consumption can be challenging, especially in the southern and eastern subregions, where a substantial amount is utilized or traded through informal channels [21]. Nevertheless, energy policies, largely influenced by cost considerations, have not been favorable to alternative energy sources or the shift away from wood-based fuels, especially during the early years of the 2010s. In the past decade, this trend has changed, with a greater focus on encouraging investments in clean energy production in line with current EU policies. If fossil fuel prices keep climbing, the utilization of wood fuels for energy will probably see a continued uptick. This aligns with

the observation made by Galatsidas [73] that wood fuel production is expected to increase to meet the growing demand. Consequently, the management of fuelwood productive forests should be carried out in a sustainable manner.

Conversely, no significant correlation was found for other wood categories, emphasizing the connection between wood removals and wood fuel production rather than the relationship between national removals and industrial wood. This suggests a notable focus on utilizing wood removals for wood fuel production rather than prioritizing the development of higher-value-added wood products. This observation aligns with the author's empirical experience.

Koulelis et al. [70] and Koulelis [74] provide a comprehensive overview of the limitations and recommendations for enhancing the organization of the national forest sector. The overarching suggestions aim to advance sustainability, economic value, and job creation within the national forest sector. Generally, the forest sectors in Mediterranean EU countries exhibit a combination of economic, environmental, and sustainable management priorities. In most cases, these sectors play significant roles in both the economies and ecosystems of the respective countries. There is a focused analysis of wood value chains, particularly in the context of pulp and paper production and biomass for energy [4,75,76]. The emphasis on shorter value chains is motivated by the goal of reconnecting domestic wood production with local consumption, revitalizing the management of abandoned forests, mitigating fire risks, creating employment opportunities in rural areas, and preserving hydro-geological stability and landscapes. This approach, which Greece could benefit from, aligns with EU policies advocating for increased wood mobilization and the adoption of a cascade use of wood. This involves prioritizing high-value wood-based products with longer service lives before transitioning to bioenergy [21].

Our findings could have implications for policymakers and stakeholders in the forest sector. Understanding the relationship between economic indicators and wood removals can inform decisions about sustainable resource management, conservation efforts, and economic development strategies. The choice of socioeconomic variables was determined by their evident correlation with the time series data of wood removals and their widespread availability within the constraints of a concise paper length. While additional data could improve the analysis, the existing dataset can be utilized for forecasting future trends in wood removals, informing strategies for sustainable resource management through the identification of patterns and trends, guiding conservation efforts by pinpointing areas where economic development might affect wood removals, and examining how employment in the mixed sector influences wood removals. Nevertheless, the investigation is also limited to broader socioeconomic variables. It does not consider parameters such as price elasticities, biomass supply chains, species composition, silvicultural practices, harvesting costs, innovative bioenergy applications, and existing policies that incentivize biomass use.

5. Conclusions

The main conclusions highlight a continuous production decline in all analyzed wood product categories and a substantial increase in imports for most categories, followed by a minor post-economic crisis dip. Moreover, the significance of urbanization, economic growth, personal income, and the workforce within the forest sector was observed in relation to wood removal production, with national imports of goods and wood fuel also playing significant roles at the national level. To conclude, we think that it is extremely important to implement practices based on a new legal framework that minimizes environmental impacts, through methods such as reforestation and responsible logging, which is vital for ensuring the long-term sustainability and productivity of forest resources, in the face of threats such as wildfires, droughts, and insect infestations. These practices can substantially impact forest productivity and health, thereby influencing timber production and the overall forest sector. The implementation of sustainable forest management plans that integrate ecological, economic, and social aspects, set clear objectives, define harvesting limits, promote biodiversity conservation, protect sensitive areas, and outline

monitoring and evaluation mechanisms are suggested. Engagement with stakeholders, capacity-building and training programs, adoption of robust monitoring systems to track forest resources, and investments in research and innovation and public awareness and education seem to be crucial. This perspective might be more beneficial for the national sector, and crucial policy and legal reforms are suggested as steps towards an organized and efficient national forest sector.

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