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MASTER´S FINAL WORK

DISSERTATION

THE IMPACTS OF THE INTRODUCTION OF A ROBOT TAX ON INNOVATION – A SCOPING REVIEW

MARGARIDA CLAUDINO MEIXEDO

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SUPERVISION:

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“Amar… é dar-se, sem que por isso se dê; É apagar-se, sem que deixe de brilhar! É ver atento o que o outro não vê; É esquecer-se dando, sem algo esperar.”

Coletânea Poética, António Meixedo

GLOSSARY

AI – Artificial Intelligence

EU – European Union

GDP – Gross Domestic Product

IFR – International Federation of Robotics

OECD - Organization for Economic Cooperation and Development

R&D – Research and Development

TFP – Total Factor Productivity

UBI – Universal Basic Income

VAT – Value Added Tax

ABSTRACT

The rapid advancement of automation has brought about discussions on the implications of robotics, in this case the robot tax. This dissertation maps the state of knowledge on robot taxation and its relationship with innovation through a scoping review. The chosen methodology showcases a two-phase framework, first conducting a bibliometric analysis to map the research landscape and then a qualitative analysis of the debate.

Existing literature shows diverging perspectives. Some scholars argue that taxing robots could mitigate job displacement and generate revenue for social programs. While others warn of potential negative consequences, such as discouraging investment in R&D and slowing down productivity growth. The goal behind this research is to fill this gap by providing a comprehensive overview of the current state of knowledge.

Despite the limited number of publications available, findings showed a growing interest in the robot tax over time. However, it became clear that there is not a proportional interest on innovation. Furthermore, findings suggest that a robot tax discourages automation and R&D, raising costs and reducing competitiveness. Additionally, while it may help reduce inequality, it lowers incentives for higher education and risks firms relocating to avoid taxation, further hindering productivity and growth.

The implications of this dissertation showcase the need for more research. Future studies could explore alternative taxation models to assess whether it is possible to mitigate inequality without discouraging innovation. Additionally, international coordination is important and should be explored. Ultimately, the impacts of a robot tax on innovation will probably depend on how said tax is designed, emphasizing the need for well-designed policies.

KEYWORDS: Robot tax; Automation; Innovation; Fiscal Policy

JEL CODES: H25; J24; O31; O33; O38

RESUMO

Os avanços tecnológicos têm gerado debates sobre as implicações da robótica, nomeadamente através da tributação de *robots*. Esta dissertação pretende mapear o estado do conhecimento sobre a tributação de *robots* e a sua relação com a inovação através de uma *scoping review*. A metodologia adotada divide-se em duas fases, começando com uma análise bibliométrica seguida de uma análise qualitativa do debate.

A literatura existente apresenta perspetivas divergentes. Alguns defendem que a tributação de *robots* poderia mitigar o desemprego tecnológico e gerar receita para programas sociais. Enquanto outros alertam para possíveis consequências negativas, como a redução do investimento em I&D e a diminuição da produtividade. O objetivo deste trabalho é colmatar esta lacuna, fornecendo uma visão abrangente do estado atual do conhecimento.

Apesar do número limitado de publicações disponíveis, os resultados indicaram um interesse crescente na tributação de *robots* ao longo do tempo. No entanto, tornou-se evidente que não existe um interesse proporcional na sua relação com a inovação. Além disso, os resultados sugerem que este imposto desincentiva a automação e o investimento em I&D, aumentando os custos e reduzindo a competitividade. Embora este imposto possa vir a reduzir a desigualdade, também pode diminuir os incentivos para o ensino superior e pode levar as empresas a relocalizar-se para evitar a tributação, o que prejudica ainda mais a produtividade e o crescimento económico.

As implicações desta dissertação demonstram a necessidade de mais investigação. Estudos futuros podem explorar modelos de tributação alternativos para avaliar se é possível mitigar a desigualdade sem comprometer a inovação. Além disso, a coordenação internacional é um aspeto importante que deve ser analisado. Por último, o impacto da tributação de *robots* na inovação vai, em parte, depender do desenho das políticas adotadas, destacando a importância de políticas bem estruturadas.

PALAVRAS-CHAVE: Tributação de robots; Automação; Inovação; Política Fiscal

JEL CODES: H25; J24; O31; O33; O38

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1.INTRODUCTION

Living in a globalized world, innovation is a driving force shaping our everyday lives. As automation increasingly takes over tasks once performed by human hands, we are witnessing a shift in how work gets done. This shift brings both opportunities and challenges, leading policymakers to rethink their approaches to labour in light of new technological advancements. Meaning that an important discussion arises for academics and policy makers regarding the possible introduction of a robot tax, which could reshape the landscape of innovation.

The concern that technological advancements could result in mass unemployment became more relevant in the 20th century and continues to be an important topic in both policy discussions and academic research today (Autor, 2015). Research on the possible introduction of a robot tax "provides policymakers with new evidence and analysis to keep abreast of the fast-evolving changes in AI capabilities and diffusion and their implications for the world of work" (Lassébie & Quintini, 2022, p. 3). In terms of job displacement, "robots do not need to physically resemble humans to play a growing role in the economy", meaning that policymakers need to think about the technology that has the potential to take over human roles (Christie, 2021, p. 8). Additionally, the robot tax raises important questions about the balance between promoting innovation and protecting workers. Researchers have discussed how existing tax systems may encourage automation by allowing companies to deduct investments in automation from their taxes (Future of Work Hub, 2019). In this light, the robot tax is seen as a tool to reduce the negative impacts caused by the replacement of human workers with robots (Acemoglu & Restrepo, 2019).

It´s clear that the introduction of a robot tax has sparked debate. While automation offers productivity and efficiency gains, it also raises concerns about job displacement, wage inequality and reduced government revenues. This dissertation aims to map the state of knowledge regarding the literature on robot tax and innovation, the respective research question guiding this work is: *How has the debate on robot taxation and innovation been structured, and what are the key arguments shaping this discussion?* That being said, the primary objective of this dissertation is to provide a comprehensive overview of the current state of knowledge on this topic. This work contributes to the literature by mapping out the terms of the debate and assess them.

Before I delve into the discussion, I would like to clarify that according to the IFR, an industrial robot is considered an “automatically controlled, reprogrammable multipurpose manipulator, programmable in three or more axes, which can be either fixed in place or fixed to a mobile platform for use in automation applications in an industrial environment”. Additionally, in some cases automation or digitalization are also used to reference robotization. So, to define what counts as a robot for tax implementation, it is important to make a distinction between these concepts. Automation refers to the process in which technologies replace humans in various tasks, ranging from digital assistants to self-driving cars (Merola, 2022). Digitalization, according to the OECD, is defined as "the impact of digital technologies and data and their use on existing and new activities". Robotization specifically involves the use of robots, particularly industrial robots, to perform tasks in production. While all robotization is a form of automation, not all automation involves robots (Acemoglu & Restrepo, 2019).

Moreover, apart from the challenges that arise in the job market with the introduction of robots, one can consider the increase of robot adoption in the last years. The phenomenon of robotization is expanding on a global scale. In 2017, it was estimated that 1.2 billion full-time workers and $14.6 trillion in wages are linked to jobs that could be automated (Chui et al., 2017). For instance, South Korea has 710 robots per 10,000 employees, followed by Singapore with 658 robots, significantly exceeding the global average of 85 robots per 10,000 employees (World Economic Forum, 2019). Moreover, robot density worldwide grew from 53 robots per 10,000 employees in 2013 to 151 in 2022, reflecting a 12% annual growth rate (IFR, 2023). Furthermore, according to the Future of Jobs report, “it is estimated that by 2025, 85 million jobs may be displaced by a shift in the division of labour between humans and machines” (World Economic Forum, 2020, p. 5). The significant increase in robot adoption provides further emphasis on the relevance of the topic at hand.

Lastly, to assess the impacts of the robot tax on innovation the present work is organized as follows: Starting with the introduction that went through the key terms, background information and objectives. The second chapter assesses what a robot tax is, its pros and cons, and existing proposals. The third chapter outlines the scoping review methodology which involves two stages: (1) a bibliometric analysis to map the literature on robot taxation and identify key trends, disciplines, and themes, and (2) a qualitative analysis of the topic. The fourth chapter presents a bibliometric analysis, assessing trends in publications, citations, and key themes related to robot taxation. Lastly, the final chapter focuses on the relationship between the robot tax and innovation, discussing the theoretical foundation´s main debates.

2.TAXING ROBOTS

This chapter focuses on providing the background for this scoping review by looking at a specific policy response, robot taxation. This will be done in the following way: An initial focus is placed on defining a robot tax and exploring some proposals that have been discussed in academic and public debates. Then, an attempt of defining robots for taxation purposes is done. Lastly, the known pros and cons of the robot tax are introduced.

2.1.What is a Robot Tax

A robot tax is a tax imposed on companies that utilize robots to replace humans, intended to compensate for the loss of personal income tax revenue and to level the economic playing field between human and robotic labour (Acemoglu & Restrepo, 2019). Moreover, the tax is levied on companies that produce or use robots instead of human labour, with the goal of mitigating the displacement effect caused by automation, where robots replace unskilled labour, leading to lower wages for these workers (Zhang, 2019).

Supporters of a robot tax usually believe that the growth of automation will generate harm to society. It´s negative impacts, such as job loss and greater economic inequality, are seen as harmful side effects, externalities, similar to pollution. Because of this, a robot tax could work like a Pigouvian tax, which is meant to discourage activities that give rise to negative externalities (Kovacev, 2020). However, several viewpoints have begun to surface, let´s delve into some of them.

Xavier Oberson explores how a tax on robots could be implemented and how it might benefit society. He proposes several approaches. One option is to apply a tax on the "imputed salary". Meaning that the company that uses robots would be subjected to a tax which would correspond to the savings of the salary of a human worker. Robots could also be subject to VAT, like how humans or companies are taxed. Oberson gives the example of a lawyer using an AI legal assistant, the cost of the AI service is included in the lawyer's bill to the client, and this bill is subject to VAT. Meaning that the AI acted as a service provider. Right now, robots are indirectly taxed through the products they help create, since businesses pay VAT on their sales. Lastly, a simpler option is to impose a fee on the use of robots, similar to drone fees. Oberson highlights the need for global coordination to ensure fairness, “it makes however little sense to develop uncoordinated robot taxes at the domestic level” (Oberson, 2022, p. 105). The aim of this tax should be to help people find a way to develop a meaningful life in a world of cohabitation with robots at a global scale.

Abbott and Bogenschneider (2017) propose an automation tax to create a fairer tax system. This includes removing corporate tax deductions for using robots, offering tax benefits when human workers are employed and increasing taxes on companies overall. The aim is to make the tax system neutral, making sure that businesses are taxed equally regardless of whether they rely on robots or human workers, so decisions are no longer driven by tax advantages. By taxing both options equally, businesses would make decisions based on what’s truly best for their work, not just what saves them money on taxes.

Chand et al. (2020) argue that imposing targeted taxes on robots may break fundamental tax policy principles like neutrality, efficiency, and fairness. Instead, they propose an education tax to fund worker reskilling and global education programs to address the societal challenges posed by automation. They believe in preparing workers for the shift in job markets rather than directly taxing AI and/or robots. The authors argue against taxing robots, as the long-term impacts on jobs are unclear. This way, instead of using taxes to limit automation, governments should focus on reskilling workers to adapt.

Kovacev (2020) argues that a robot is not easily defined for tax purposes, meaning that a tax on robots represents a tax on humans, “should a robot collect money, it does so on behalf of its human owner, and legally must do so in the name of that human agent” (Kovacev, 2020, p. 196). However, deciding who should pay a robot tax is tricky. Should it be the manufacturers who makes the robots, the businesses that buys and uses them, or the consumers of the goods produced by the robots (Kovacev, 2020)? For example, what happens if a business uses robots but doesn’t fire employees, or replaces low-skilled workers with high-skilled ones? Also, if the tax is based on income generated by robots, it would be difficult to assess which income comes from robots and which doesn't. As Kovacev (2020) proposes that this would likely require a case-by-case analysis, which can be hard to implement.

2.2. What Constitutes a Robot for Tax Purposes

There is a consensus regarding the difficulty of defining a robot for taxation purposes, which is crucial for implementing a robot tax. "Is a robot an asset capable of executing an action that would typically be executed by a human, or is a robot also a process that can outperform human beings?" (Falcão, 2018, p. 1275). Defining what constitutes a taxable robot is not simple, it is a significant challenge because "few complex technologies have a single, stable, uncontested definition, and robots are no exception" (Kovacev, 2020, p. 192).

Xavier Oberson argues that a robot should be defined in the broad sense of the term in accordance to the functions that the robot is capable of doing. "The concept of robots for tax purposes should not be based on its physical form, but a "form-neutral" definition of robots" (Oberson, 2022, p. 104) focusing on: 1. Smart robots (autonomously interact, learn, and make decisions); and 2. Algorithms as tax subjects (systems that handle economic transactions without needing humans). Under this definition a self-driving car would be a robot, but not the car itself, it´s about the autonomous intelligence and capacity to make decisions. Additionally, Oberson highlights the legal personalities of robots, he argues that granting robots legal personalities would allow them to be taxed like corporations, ensuring they are legally accountable, which consequently requires a clear definition of what a robot is.

Additionally, according to Popovič and Sábo (2022), a taxable robot can be defined through three main approaches: 1. Based on Capabilities; 2. Based on Use; and 3. Based on Design. The first approach focuses on what the robot can actually do. It distinguishes between robots and other automated systems by determining their ability to replace humans. The based on use approach classifies robots according to their intended application, such as industrial robots, medical robots and so on. Lastly, the design approach relies on the technical factors of how robots are built, such as the technologies used. The authors concluded that the solution to the definition of a taxable robot involves creating a tax nomenclature that classifies robots based on two main attributes: the level of autonomy of the robot and its intended purpose and use. For example, if a robot has multiple uses, it can be given different classifications that correspond to its different uses. For multipurpose robots, their classification and taxation would depend on their actual use, which would need to be documented and verified. As for the degree of autonomy, the classification would include the following distinctions: 1. Robots with a human operator; 2. Robots that need initial human input but can operate semi-independently and; 3. Completely autonomous robots that operate without human intervention (POPOVIČ & SÁBO, 2021).

2.3.The Pros and Cons of Taxing Robots

This section aims to put forward the primary points on view on the robot tax, highlighting what are the known pros and cons in the literature. Xavier Oberson argues that robot use is increasing in many sectors of the economy and jobs are disappearing. He highlights that optimists on the robot tax believe that while AI will eliminate many jobs, it will also create new ones, possibly even more than before. For them, this is positive as productivity is increasing, new jobs appearing and dangerous jobs will be replaced. Others think otherwise, new jobs can indeed be discovered and others replaced. However, robots are not just replacing industry jobs but could eventually replace human thinking as well. These people fear that robots could replace most if not all jobs. However, the question regarding who is right between these distinct points of view remains unanswered, “we don’t know who is right or wrong in this debate. However, we still believe that many jobs will disappear because of the development of AI” (Oberson, 2022, p. 101). It´s clear that a robot tax presents both advantages and challenges, with arguments on both sides of the debate meaning that the introduction of a robot tax can be seen as a tool that addresses externalities, the unwanted/wanted side effects of economic activities that impact people in large scale. Let´s delve into the main points for and against the robot tax.

Supporters of a robot tax highlight several key benefits. Automation is often seen as a crucial driver of productivity for many and, robots are no different. For example, investments in robots contributed to 10% of GDP growth per capita in OECD countries from 1993 to 2016. This indicates that robots help increase efficiency, allowing economies to produce more goods and services per hour worked (Atkinson, 2019). Furthermore, one major advantage is its potential to support social programs by generating revenue that can be used for education, retraining, and social security for displaced workers. Governments should prioritize reskilling workers through education rather than implementing support policies that only provide minimum wage assistance through the robot tax (Chand et al., 2020). Moreover, it´s "crucial to create synergies across policies and a strong link between employment creation strategies, redistributive policies, skill development and social protection systems" (Merola, 2022, p. 2). Additionally, a robot tax could help recover lost income tax and social security contributions, compensating for the reduction in human labour (Acemoglu & Restrepo, 2019). For instance, like previously mentioned, Oberson suggests a tax on the "imputed salary," meaning that companies using robots could be taxed based on the equivalent salary savings of a human worker they replace, which consequently would help to recover lost income taxes. Another argument in favour of this tax is that it promotes fairness, ensuring that businesses that use automation contribute equally when compared to companies that mostly rely on human workers (Acemoglu & Restrepo, 2019). "With a level playing field, firms should only automate if it will be more efficient, without taking taxes into account" (Abbott & Bogenschneider, 2017, p. 152). Finally, some argue that such a tax could encourage human employment by correcting the current tax system, which tends to favour automation over human labour. Abbott and Bogenschneider (2017) argue that a neutral tax structure that applies equally to robots and workers could increase the attractiveness of hiring humans. In the author's own words, "since the current tax system favours automated workers, a move toward a neutral tax system could increase the appeal of human workers" (Abbott & Bogenschneider, 2017, p. 152). The major advantage of tax neutrality put forward by the authors is that it allows the market to adjust without any tax distortions.

However, critics of a robot tax highlight several different arguments. One major concern is the difficulty of defining what constitutes a robot for taxation purposes and the complexity needed to coordinate international efforts, this difficulty was previously discussed in this chapter. Another issue is global competition, as countries that introduce a robot tax may become less competitive when compared to those that do not (De La Feria & Grau Ruiz, 2022). Whilst there are negative externalities with increased robotization, "it is also true that it would negate the productivity and welfare gains that would be made in addressing future global challenges such as demographic changes - taxing the use of robots could in effect amount to "shooting one-self in the foot" " (De La Feria & Grau Ruiz, 2022, p. 2). Additionally, legal challenges arise, with some arguing that robots would need to be granted legal status to be held accountable for tax obligations, which complicates the enforcement of said obligations (Oberson, 2022). Lastly, the most significant concern is the potential risk of stifling innovation. By discouraging investment in automation, a robot tax may reduce productivity and economic growth, making industries less efficient in the long run (Atkinson, 2019). This point will be further discussed in chapter five.

To conclude, it´s clear that this discussion has divergent views, as "the productivity boost from AI is expected to increase global growth rates by an order of magnitude. At the same time, AI and automation may also have a negative impact on the groups of workers who lose out in the competition with new generative AI tools" (Bastani & Waldenström, 2024, p. 14). All in all, the debate over robot taxation shows a balance between addressing economic and social challenges while ensuring innovation and competitiveness in the global economy.

3.TOWARDS A SCOPING REVIEW – A METHODOLOGY

The objective of this dissertation is to provide an overview of the current state of knowledge on the implications of the robot tax on innovation. To reach this objective, a scoping review methodology was chosen and structured in two phases. First, a bibliometric analysis to map the research landscape. Second, a qualitative exploration of the topic. The purpose of this chapter is to outline the methodological approach adopted for this research. The chapter is divided into two sections. The first section justifies the choice of this methodology by comparing it to other types of reviews and showcasing why the chosen methodology is the best fit for the topic. The second section goes through the data collection and selection process, including database searches, inclusion and exclusion criteria, and the systematic approach used.

3.1. Why a Scoping Review

The choice regarding the type of review was based on three criteria. First, the exploratory nature of the thesis objective, which requires flexibility. Second, the fact that the literature on the topic is still in its early stages, meaning that existing research is limited. Lastly, the need for a systematic process. In this light, to conduct this work, three different approaches were considered 1. systematic review; 2. narrative review; and 3. scoping review. Systematic reviews follow a structured approach, including literature searches with strict criteria, assessing the quality of the chosen studies (Lau & Kuziemsky, 2016). This type of review is valuable in evidence-based practices and is commonly used in fields related to care and therapeutics (Lockwood et al., 2019). The disadvantages of systematic reviews, include the fact that they are often constrained by the available literature, making it difficult to conduct useful reviews when there is not a lot of existing research (Lim et al., 2022). For this reason, a systematic review was not considered to be the best fit as there is not a lot of empirical data regarding the impacts of the introduction of a robot tax on innovation.

Narrative reviews are a type of review that tell the story of what's known on a topic. They provide a broad overview of a topic, offering insights into current knowledge, and are useful for summarizing large bodies of work (Grant & Booth, 2009). However, narrative reviews are often criticized for being subjective as they don't have clear rules for choosing which studies to include, resulting in an unsystematic view of the research (Lau & Kuziemsky, 2016). All in all, they summarize existing literature but do not seek general knowledge from what is reviewed (Lau & Kuziemsky, 2016), so this methodology was dropped.

Lastly, scoping reviews attempt to provide an initial indication of the potential size and nature of the literature on a new topic (Lau & Kuziemsky, 2016). The whole point of scoping the field is to be as comprehensive as possible. The main purpose of a scoping review is to synthesize research evidence in a way that is different from systematic reviews (Lockwood et al., 2019). Systematic reviews are best for answering specific, clearly defined questions. Whereas scoping reviews are better suited for broader questions, such as "What evidence exists for this intervention?" or "What is known about this concept?" (Tricco et al., 2018).

The topic of robot taxation is still evolving, meaning that a scoping review is useful for mapping the existing research landscape, identifying what is already known, and highlighting areas that require further investigation. This type of review was chosen as it provides an overview of available evidence (Campbell et al., 2023). To conclude, scoping reviews map existing literature, identify gaps, and integrate different perspectives, making them a good fit for understanding the topic at hand. Additionally, as it has already been mentioned, the objective of this work is to assess the state of the art in the literature regarding the potential impacts of introducing a robot tax on innovation. To do so, the scoping review is organised as follows:

1. A bibliometric analysis on the robot tax will be conducted. The discussion aims to map the literature on robot taxation and determine the main trends in which this topic emerges. Furthermore, it aims to identify the evolution of the topic as well as assessing the fields where this debate is happening and the overall themes under discussion.
2. Building on this mapping exercise, the insights gained from the bibliometric analysis will be used for a qualitative analysis. This second stage of the work will explore the literature specifically focused on the potential impacts of a robot tax on innovation.

This discussion is important as there are concerns that a robot tax could slow down investment, and therefore potentially slow down or hinder innovation. Meaning that the purpose of this two-stage approach is to provide a comprehensive overview of the academic discourse on robot taxation and its connection to innovation, allowing for a good understanding of the key arguments and trends in the current research. Moreover, it´s important to mention that bibliometrix in R-Studio is the chosen tool for this bibliometric analysis.

3.2.The Search Analysis

In this section a search strategy for the review is developed, including the choice behind databases, keywords and date ranges regarding publications on the topic over the years. The PRISMA protocol (Tricco et al., 2018) was followed to address the stages of identification, screening and inclusion of the articles. Additionally, the guidelines of Donthu et al. (2021) will also be taken into consideration. According to these authors, "bibliometric analysis is useful for deciphering and mapping the cumulative scientific knowledge", hence why the choice to add this chapter (Donthu et al., 2021, p. 1). The search equation decided upon is the following:

(robot OR automat*) AND (Tax OR taxation OR (fiscal Polic* OR tax polic*)) AND (innovation OR (R&D* OR technological innovation*)).*

However, for the 4th chapter of this dissertation that focuses solely on the bibliometric analysis of the robot tax, the search strategy conducted was as follows[1]:

[Title] OR [Keywords]: (robot* OR automat*)

AND

[Title] OR [Keywords]: (Tax OR taxation OR (fiscal Polic* OR tax polic*))

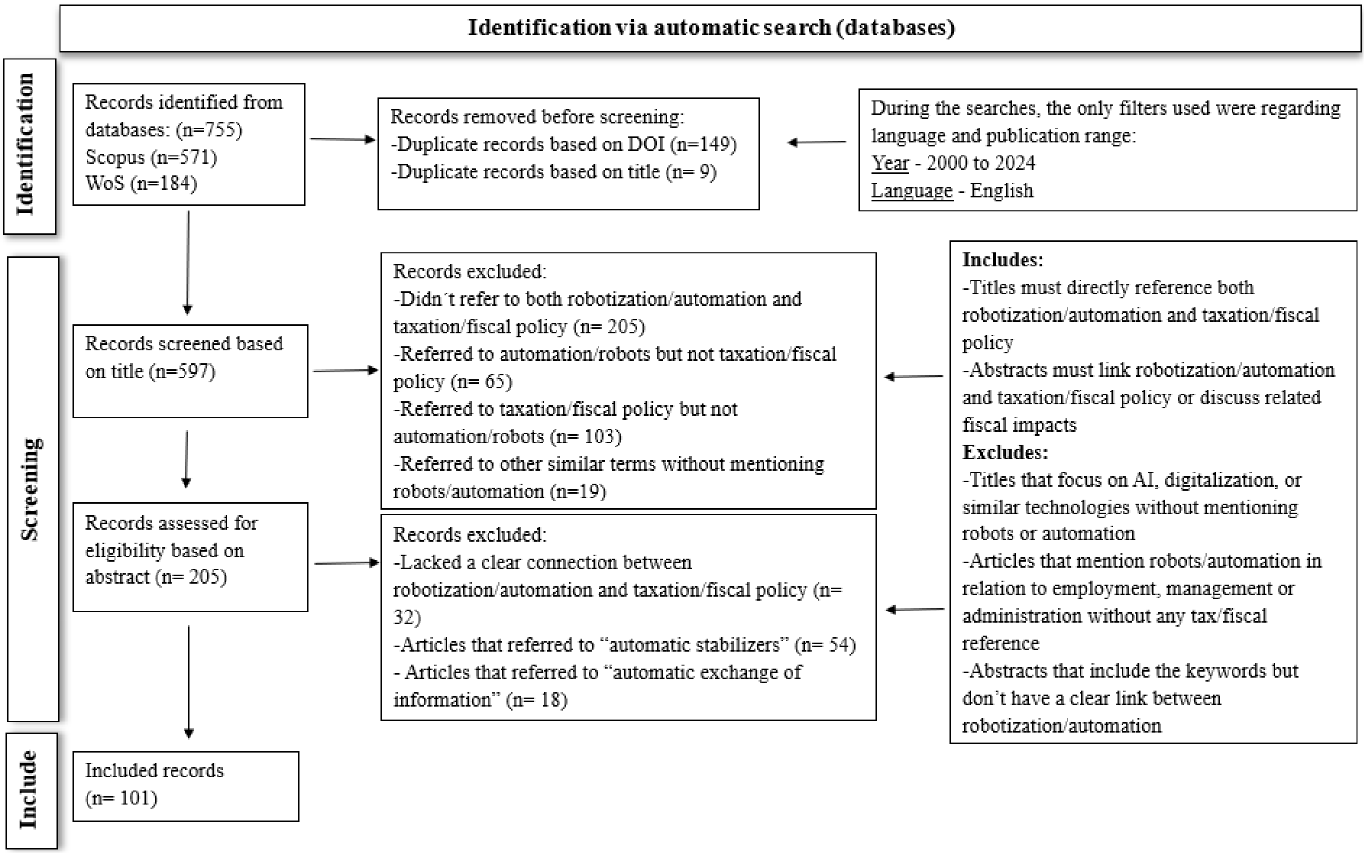

Figure 1.PRISMA Protocol[2]

The PRISMA protocol results are above in figure 1. Since two separate databases were used, the software Zotero was used to work on the data. After downloading the data to Zotero, the screening process went as follows:

- The first sets of duplicates were eliminated based on the DOI;
- Other duplicates were eliminated based on the title;
- Titles that didn´t fit the inclusion criteria were eliminated;

[1] The respective syntax can be found in table 3 in the appendices.

[2] The inclusion/exclusion criteria is summarized in table 4 in the appendices and, the criteria aligns with the PRISMA protocol (Tricco et al., 2018) by defining the said criteria across key areas and ensuring a systematic screening process.

- Other articles were screened based on the abstract.

The PRISMA protocol in figure 1 shows the systematic process used to identify and screen articles for this study, following two key phases: Identification and Screening. The process began with the identification phase, where a total of 755 records were retrieved from two databases: Scopus (571 records) and Web of Science (184 records). During the searches, the only filters used were regarding language and publication date. The duplicates were excluded in two steps, based on DOI and based on title. After removing the duplicates (149 based on DOI and 9 based on title), 597 unique records remained for screening.

The screening phase was done in two stages: first title and then abstract. During the title screening phase, 392 records were excluded for several reasons. Titles needed to include the terms “robot*” or “automat*” with “tax” “taxation”, “fiscal polic*” or “tax polic*”. 205 did not address both robotization/automation and taxation/fiscal policy, 65 referred to automation/robots without discussing taxation/fiscal policy, 103 focused on taxation/fiscal policy without mentioning automation/robots, and 19 mentioned other technologies in their respective titles like such as AI without using the automation/robots. This step reduced the sample to 205, these articles were then assessed based on their abstracts.

In the abstract screening phase 104 records were excluded. Abstracts needed to establish a clear connection between robotization/automation and taxation/fiscal policy or discuss related impacts on fiscal mechanisms, even if indirectly. For example, if it included topics such as technological unemployment, inequality, or UBI. There were 32 articles that lacked a clear connection between robotization/automation and taxation/fiscal policy. These papers contained the decided upon keywords and met the inclusion criteria regarding their titles. However, they didn´t discuss the taxation of the automation they mentioned. For example, the paper “Automated Tax Mapping from UAV Multispectral Imagery” discussed the use of high-resolution UAV imagery to streamline real estate tax mapping in India. Although it mentions both automation and taxes it´s not relevant for the present work. There was not a common theme amongst these abstracts that allowed for a categorization but the reasoning behind their exclusion lies in the fact that these mention automation for tax purposes but not the taxation of the technology itself.

Moreover, 54 of the excluded articles focused on unrelated macroeconomic topics such as “automatic stabilizers”, these mainly focused on a corporate tax or a personal income tax and their impacts on the economy. Lastly 18 discussed “automatic exchange of information” in contexts unrelated to taxing automation. These included the keywords decided upon. However, even though these referred to the automatic exchange of information for tax purposes, these articles don’t mention the taxation of said automation.

In the end, 101 records were kept as they are relevant for the bibliometric analysis.

4.THE ROBOT TAX – A BIBLIOMETRIC ANALYSIS

This chapter presents a bibliometric analysis to assess the discussions on robot taxation. The aim is to understand how this topic has been researched over time by identifying key trends in publications and assessing its importance within the academic discussion. The analysis is divided into three main sections to ensure a structured approach. The first section focuses on impact, by using the evolution of the number of publications and citations as an indicator, this section analyses how interest in the topic has developed over recent years. The second section addresses the disciplinary approaches, it identifies the theoretical perspectives from which the topic has been analysed. Finally, the third section delves into the major themes, it examines the main themes that dominate the literature on this subject.

4.1.An evolving research topic

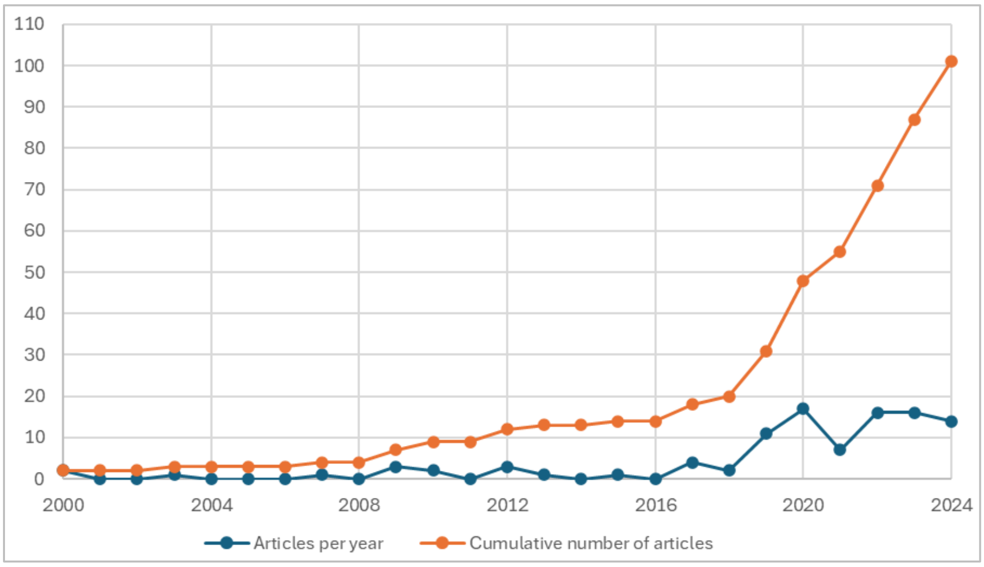

Figure 2. Trend in Number of Publications

Figure 2 shows that the number of publications has increased from 2000 to 2024, during this time the annual growth rate is 8.45%. The main observation one can take from this figure is the steep jump on number of publications from 2017 onwards. The yearly average of publications from 2000 to 2016 is only 0.82 articles, showcasing that there was very little growth, with just a few articles published annually, ranging from 0-3 publications. This suggests the topic wasn't getting much attention at that time. A shift occurs from 2017 onwards as the number of publications began to rise. From 2017 to 2024 the average of articles published every year grew to 10.87 and, by 2020, the number peaked at 17 articles. However, after 2020, there is a slight decline in the number of publications, this decline can be explained due to the Covid-19 pandemic. Despite this fluctuation there is still a significant level of activity. These findings show that the topic is evolving and the trend in number of publications reflects the growing evolution of this field.

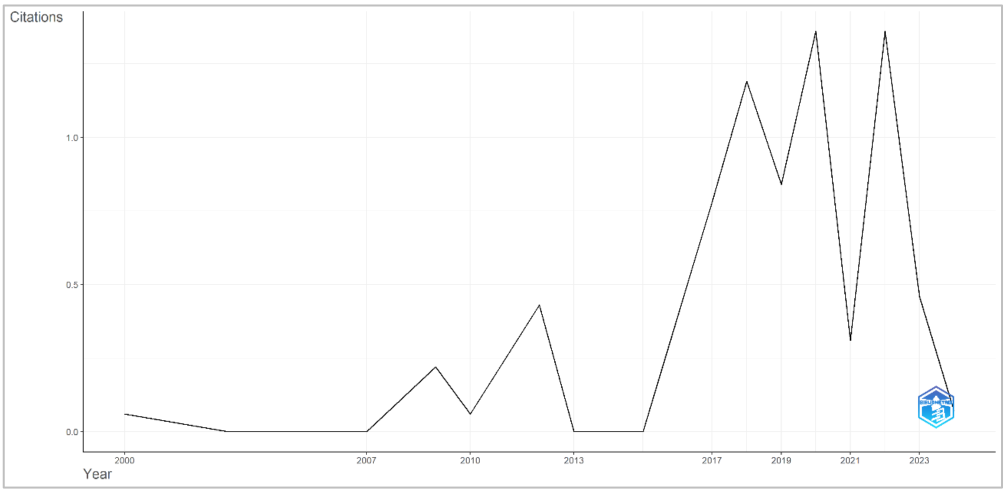

Figure 3. Citation impact per year

Furthermore, figure 3 reveals a pattern of growing citation impact over time[3]. From 2000 to 2015, the citation levels are low, with minimum average citations per article. A significant increase in the number of citations occurred from 2016 onwards, indicating the start of a period of high interest in this topic, resulting in the first peak of 2018. The period between 2018 and 2022 marks the peaks of citation activity. However, it´s important to mention the significant decline in the number of average citations in 2021,

[3] The average citations per year can be found in table 5 in the appendices

that goes hand in hand with the decline in number of publications during this year. Figure 3 shows that the key period of academic impact on this topic is from 2018 to 2022.

Additionally, it´s important to mention that citation trends do not always directly go hand in hand with publication outputs. Citations peaked earlier than publications (citations peaked in 2018 and publications peaked in 2020), indicating that articles from 2018 had big influence despite a lower publication volume. However, the second spike in number of citations occurs during the first spike in number of publications.

4.2.Intellectual structure of the debate

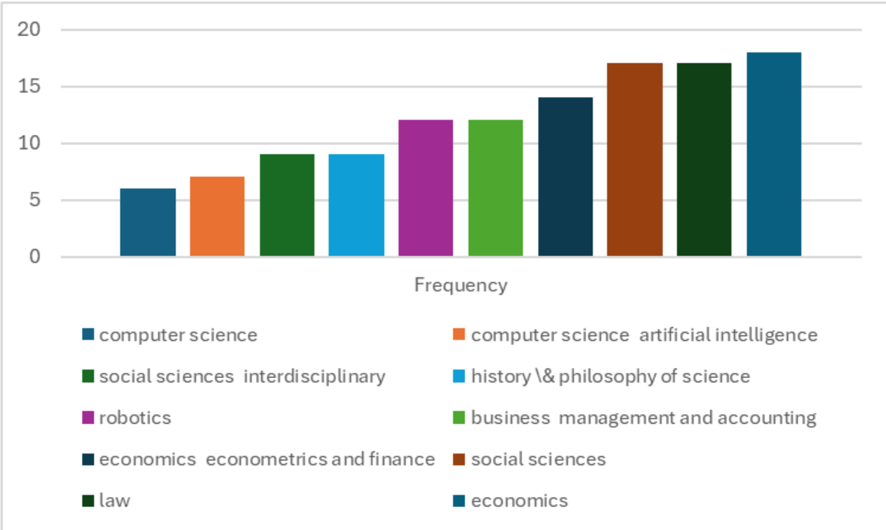

Figure 4. Subject categories

Figure 4 shows the trend in number of publications per discipline, the top ten disciplines[4]. Economics is the largest category, with a total of 18 articles (15%). This is closely followed by social sciences and law, each with 17 articles (14%), highlighting the importance of the legal frameworks of robot taxation. Other important areas include economics - econometrics and finance (14 articles, 12%), showing a focus on quantitative

[4] These subject categories are a mix of data from both scopus and web of science. These databases have some differences in their subject classifications. In Scopus, titles are organized into four broad subject areas, which are further divided into 27 subject areas and over 300 minor subject areas, allowing for a very detailed categorization. In contrast, Web of Science employs a more rigid system with over 250 subject categories that are generally broader than those in Scopus. In this light, it´s important to mention that some of the papers are connected to more than one discipline. In addition, since there are some differences in the subject areas created by the databases, their respective categories may be different depending on where the article is searched.

data within the economics field. Categories regarding business management, accounting and robotics are equally significant, with 12 articles (10%) each. Smaller but still important categories include philosophy and social sciences (9 articles, 7% each). Additionally, computer science and AI related disciplines account for a total of 13 articles (11%), showcasing the role of technology in the research. The figure shows a balance between traditional disciplines like economics and law and growing fields like robotics and AI. This reflects the broad nature of the research.

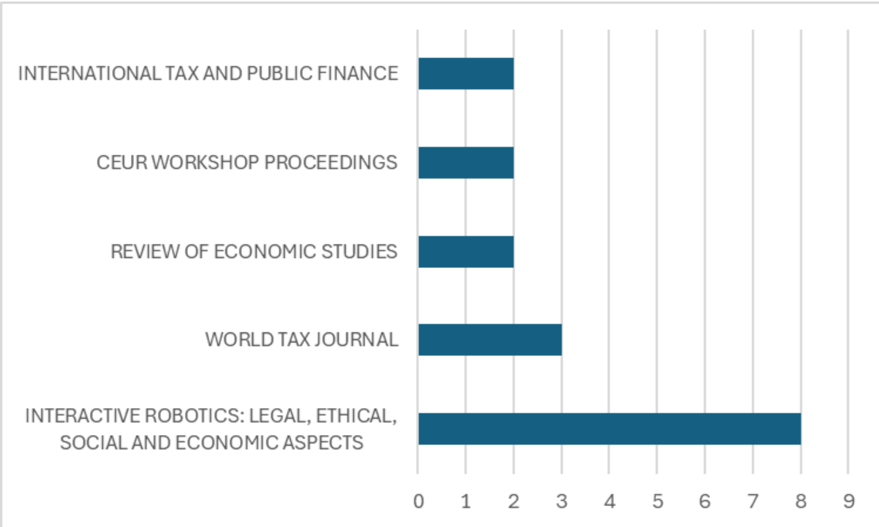

Figure 5. Total publications per leading journal

Figure 5 shows the distribution of research output amongst the 5 leading journals from this sample. The journal "Interactive Robotics: Legal, Ethical, Social, and Economic Aspects" leads with the highest number of publications, 8 publications. This is followed by the "World Tax Journal", with 3 publications. Other journals, such as the "CEUR Workshop Proceedings", and "International Tax and Public Finance" and “Review of Economic Studies”, each feature fewer publications. This distribution showcases more research effort in some areas, particularly the relationship between robotics and economics. Additionally, the scientific areas to which these journals belong to are showcased in table 1 below.

Journal	Subject categories
REVIEW OF ECONOMIC STUDIES	ECONOMICS
INTERNATIONAL TAX AND PUBLIC FINANCE	ECONOMICS
CEUR WORKSHOP PROCEEDINGS	COMPUTER SCIENCE
WORLD TAX JOURNAL	BUSINESS, MANAGEMENT AND ACCOUNTING; ECONOMICS, ECONOMETRICS AND FINANCE; SOCIAL SCIENCES
INTERACTIVE ROBOTICS: LEGAL, ETHICAL, SOCIAL AND ECONOMIC ASPECTS	HISTORY \& PHILOSOPHY OF SCIENCE; LAW; ROBOTICS; SOCIAL SCIENCES, INTERDISCIPLINARY

Table 1. Journal corresponding scientific area

To conclude, the three main disciplines contributing to research on robot taxation shown in figure 4 are economics, law, and social sciences. The influence of these disciplines is reflected in figure 5: "Interactive Robotics: Legal, Ethical, Social, and Economic Aspects" leads in publications, highlighting the role of law and ethics. "World Tax Journal" emphasizes the economics aspect. Both journals tie to social sciences. Table 1 further reinforces this as the subject categories from the leading journals align with the top three disciplines in the sample.

4.3.Key Themes

Author Keywords	Occurences
automation	29
robots	15
taxation	10
artificial intelligence	9
tax	8
robot tax	6
tax policy	6
efficiency	4
inequality	4
digital economy	3
economic growth	3
growth	3
optimal taxation	3
taxes	3
technological unemployment	3

Table 2. Author Keywords

Table 2 shows the top 15 author keywords alongside their respective occurrences. The top five keywords - automation, robots, taxation, AI and tax – clearly show a focus on technological terms. The keyword "automation" is in the front with 29 mentions, followed by "robots" with 15 mentions, “taxation” with 10 mentions, "artificial intelligence" with 9 mentions, and “tax” with 8. Moreover, the position of the words “taxation” and “tax” in the top five only goes to show that there is a clear focus on the regulatory and policy challenges posed by robots. Moreover, the keyword “tax policy” with 6 occurrences proves this point even further. Apart from the top five keywords, special attention should be given to “efficiency” and “economic growth” each occurring four and three times respectively. These two words are of upmost relevance in regards to robot taxation. “Economic growth” is relevant as it assesses the economic implications of a robot tax. The word “efficiency” reflects the productivity gains that come with automation. Additionally, it can also reflect the concerns about the trade-offs associated with automation, such as job displacement.

Figure 6 showcases the co-occurrence network of author keywords. The larger nodes represent the most frequently discussed topics and, the lines connecting these nodes show how often these terms appear at the same time in the literature, these lines differ in thickness, highlighting the strength of the connections between terms.

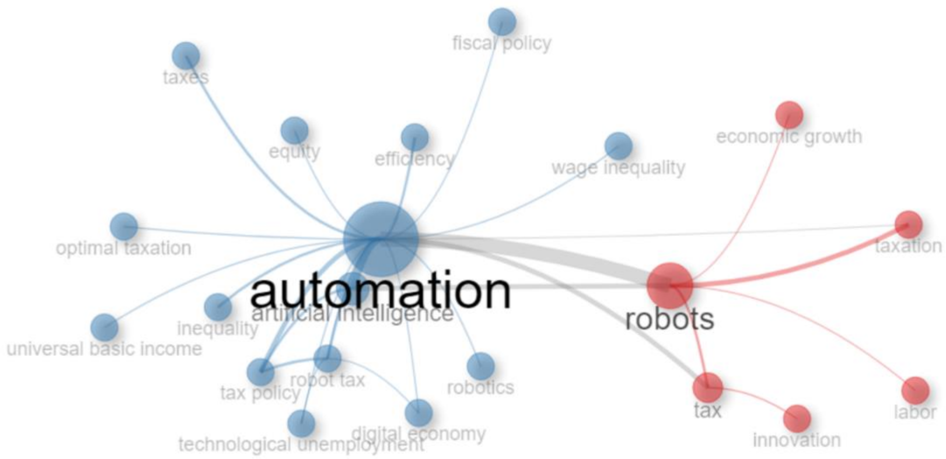

Figure 6. Co-occurrence network analysis of Author Keywords

At the center of the network in figure 6 is the word "automation," which forms strong connections with terms such as "robots," "artificial intelligence," "robotics," "universal basic income," and "tax policy." The size of the nodes clearly shows that "automation" is the primary research focus. Additionally, there is a visible link between "automation" and terms like "efficiency," "technological unemployment," "taxes," and "optimal taxation," showcasing that existing literature mainly focuses on the economic and labour market impacts of automation. Furthermore, “robots” are mostly connected to terms such as “taxation”, “tax” and “economic growth” which points to the growing debates on the possible introduction of a robot tax. Moreover, the appearance of the keyword “innovation”, which is the focus of the present work, is particularly relevant as it highlights the growing concerns of the impacts such a tax would have on innovation, and it shows a possible path for future research. However, "innovation" is not extremely emphasized in this network, which means that existing research focuses more on the direct economic implications rather than innovation-driven consequences.

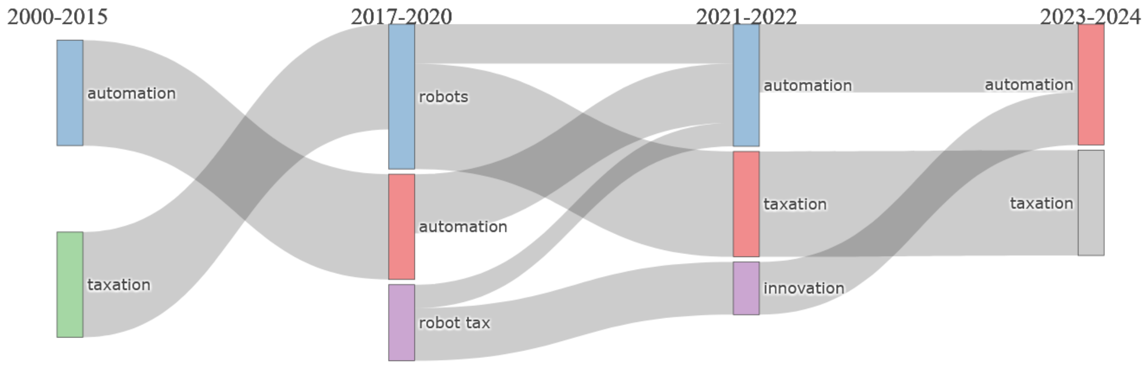

Figure 7. Thematic evolution of author keywords

Figure 7 shows the evolution of author keywords in the literature over four different time periods: 2000–2015, 2017–2020, 2021–2022, and 2023–2024. Each vertical bar represents the main themes during the chosen specific time period. The grey lines show the connection of the themes and show their transformation over time.

In the first period (2000–2015), the main themes were "automation" and "taxation”. Moving into the second period (2017–2020), new themes appeared, such as "robots" and "robot tax", showcasing a growing interest on the debate surrounding the taxation of robots. At the same time, "automation" and "taxation" continued to be significant fields of study. In the third period (2021–2022), the themes "automation", "taxation", and "innovation" are the most prominent. The continued presence of "automation" and "taxation" only goes to show their relevance, while the appearance of "innovation" showcases a growing concern about the impacts of a robot tax on innovation. Lastly, in the most recent period (2023–2024), "automation" and "taxation" continue to be of upmost relevance for academics. Additionally, "innovation" also continues to be a relevant theme as the grey line transitions “innovation” towards “automation”, highlighting the interplay between these themes. To conclude, figure 7 provides a thematic evolution where core topics like automation and taxation remain persistent across all time periods, while new themes like robots, robot taxation, and innovation emerge.

5.TAXING ROBOTS AND ITS IMPACTS ON INNOVATION – A STATE OF THE ART

This chapter assesses how research on the impact of a robot tax on innovation aligns with the broader debate on robot taxation. To reach this objective, this chapter is organized as follows. Firstly, an assessment of how important innovation is within the body of literature on the robot tax will be conducted through two different metrics. The second section aims to assess the state of the debate of the impact of robot tax on innovation. To do so, the two main perspectives regarding the robot tax in the literature will be presented as well as the core assumption that drives this debate. Additionally, this section goes through the different theoretical foundations and impacts that are known in the literature. It´s relevant to mention that this section contains institutional literature apart from the one used in the bibliometric analysis.

5.1.How Important is Innovation for the Literature on the Robot Tax?

In order to assess how important innovation is within the body of literature on the robot tax the sample from chapter four will be used in this section. In reality, from the 101 articles in this sample, very few discussed innovation. However, 9 out of the 101 were used to make this assessment[5].

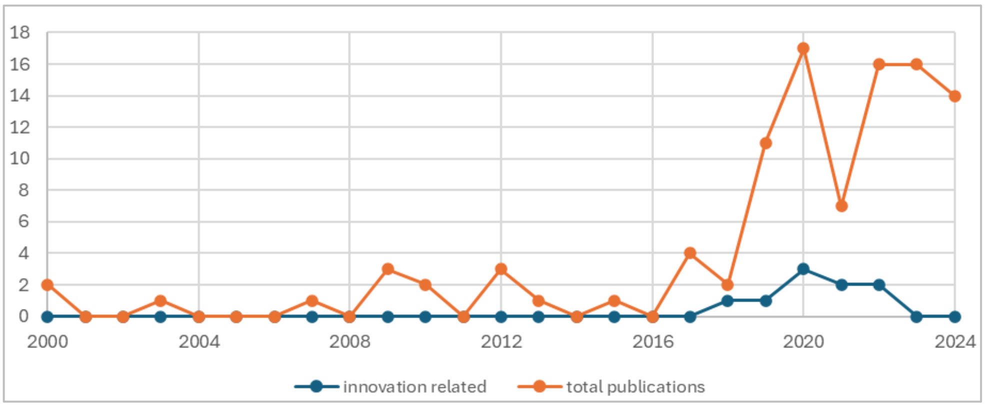

Figure 8. Innovation related publications vs total publications per year

[5] Four articles contained "innovation" in the author keywords, two articles contained "innovation" in the keywords plus and three articles contained "innovation" in their respective abstract.

Figure 8 shows the number of innovation related publications compared to the total number of publications per year on the robot tax from 2000 to 2024. Out of the total number of papers, only 8.9% are innovation related. This low percentage clearly shows that despite the growing interest in the robot tax, there is not a proportional interest on its effects on innovation. In addition, the peak in the total number of publications in 2020 also reflects the peak in the number of publications in regards to innovation (3 articles in 2020). The significant gap between innovation related publications and total publications shows that there is a need for more focused research on the impacts of the introduction of the robot tax on innovation.

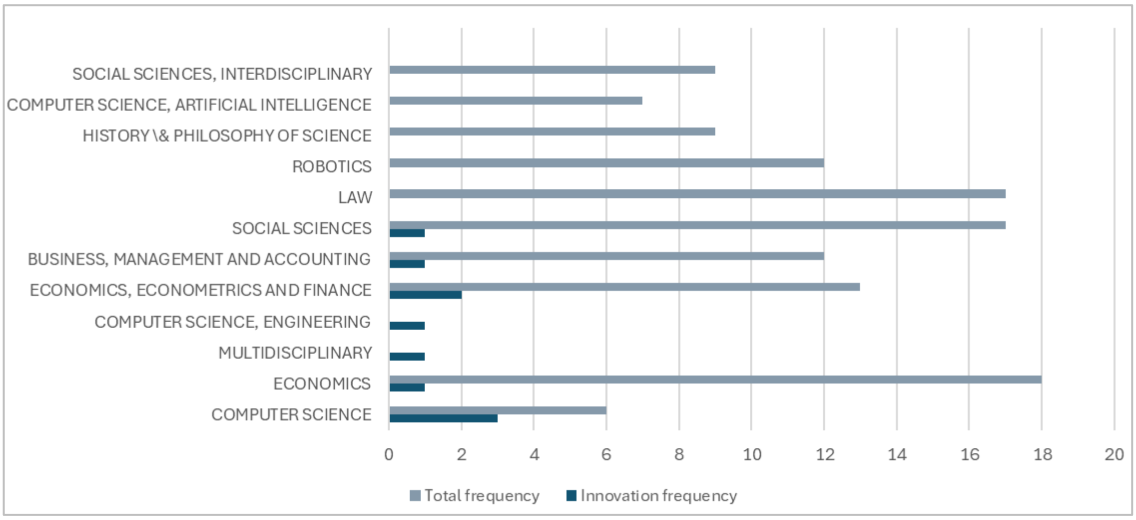

Figure 9. Subject categories of innovation related publications vs total publications

Figure 9 showcases the subject categories of innovation related publications compared to total publications. Innovation related publications are primarily discussed by the computer science discipline. This focus reflects a big emphasis on technology and its impact on innovation. Moreover, the computer science category highlights the importance of technological research in driving innovation. Contrarily, the total publications show a broader discipline range, with the largest categories being from economics, law and social sciences, indicating a broader assessment of the robot tax, particularly its economic and legal implications. Furthermore, the economics discipline still has some relevance for innovation, with 5.6% of its publications addressing innovation-related topics. Economics, econometrics, and finance has 15.4% of its publications linked to innovation, showing a stronger importance compared to economics alone. Other relevant subject areas include business, management, and accounting with 8.3% of the total publications being innovation-related, while multidisciplinary research has 100% of its publications related to innovation, despite the small representativeness.

5.2.State of the debate on the impact of robot tax on innovation

Since the impact of a robot tax on innovation is not yet fully known, there are several debates shaping its discussion. This section aims to identify the main standpoints known within the literature regarding the impacts of the robot tax on innovation, the types of arguments that support these standpoints, and the authors associated with each type of argument. It´s important to mention that priority will be given to empirical evidence[6].

Before delving into these standpoints, I would like to first provide some contextual information. In the next 40 years, 80% to 90% of economic growth is expected to come from productivity gains, driven by innovation. However, the spread of innovation across different industries has been slow, resulting in small productivity growth. This slowdown not only affects countries' economies but also worsens inequality (World Economic Forum, 2019). For this reason, in order to tax robotization, it must be done in a way that doesn´t hinder innovation. In this light, policy design plays an important role in shaping the pace of innovation. By influencing the cost of adopting new technologies, tax policies have the power to influence whether firms invest in new technologies. Policymakers have a key role in encouraging the spread of new technologies and setting goals for innovation, while also making sure businesses compete fairly (World Economic Forum, 2019).

Delving into the main standpoints, the debate on the implementation of a robot tax in the literature presents two main viewpoints. Some argue that a robot tax is necessary to address the challenges posed by automation, while others believe that such a tax would reduce fiscal incentives for adopting robots. At the center of this debate lies the assumption that more innovation leads to more productivity, which consequently drives economic growth. Supporters of automation argue that technological advancements create new opportunities, while critics fear it could lead to significant negative effects for society.

[6] Within the sample from chapter four, the papers that specifically focused on the impact of the robot tax on innovation were identified and complemented with institutional publications (grey literature).

Those in favour of a robot tax highlight two key viewpoints. First, they argue that it can help prevent mass technological unemployment by slowing down the pace of automation and making sure that human workers continue to be relevant in their jobs. Acemoglu and Restrepo (2019) support this concern by explaining that automation affects employment through two forces: the displacement effect and the reinstatement effect. New technologies change the way in which we produce and, the authors argue that this shift, known as the displacement effect, reduces the role of labour in creating value. An example of this type of technology is agriculture, without it´s advancements, it wouldn't be possible to feed the world´s population. While this began with significant displacement of agricultural workers, it also created a huge increase in production, known as the productivity effect. "The tractor alone increased agricultural production in a powerful way – far beyond that which could be accomplished by a single farmer" (Schulze & Mock, 2021, p. 305). Meaning that robots allowed for more efficiency in the production process which led to the increase of productivity. This situation creates a surplus of the demand for non-automated jobs, as now machines can do the same as humans but at a much faster pace (Acemoglu & Restrepo, 2019). Moreover, the reinstatement effect happens when technology creates new types of jobs. The reinstatement effect consists of the new jobs that compensate for the initial displacement caused. Going back to the example of agriculture, displaced workers didn't stay unemployed forever, instead, most moved to the city and learnt new skills. Additionally, it´s important to mention that Acemoglu and Restrepo (2019) show concern regarding an imbalance shown in recent years: while automation has increased, the creation of new jobs has slowed down. The authors argue that without intervention (the robot tax), the labour market may not adjust quickly enough to absorb displaced workers, increasing the risk of technological unemployment. The authors suggest that policies should focus on fixing these imbalances and ensuring that technological progress leads to both innovation and job creation. Their main argument is that automation has outperformed the creation of new jobs, but with the right policies, it's possible to redirect technology in a way that benefits both workers and growth. Additionally, Joseph and Falana (2021) studied the connection between AI and firm performance in Nigeria and, put forward a balanced and mostly positive view on the effects of robot taxation on innovation. They believe that a well-designed robot tax can encourage companies to develop AI technologies that complement humans rather than replace them, fostering inclusive innovation. They state: “policies should be enacted that will promote socio-economic inclusiveness like reducing redundancy of human workforce through robot taxation” (Joseph & Falana, 2021, p. 52). Furthermore, they mention that “the conceptualization of Robotic Taxation represents theoretical innovation” (Joseph & Falana, 2021, p. 23). Meaning that the robot tax can be structured to encourage innovation.

Second, a robot tax is seen as a tool to reduce wage inequality. As automation advances, there is a risk that economic benefits will become concentrated among capital owners and highly skilled workers. Mazur (2019) argues that the current tax system favours capital over labour income, worsening inequality as it is “generally owned by the wealthy, and this would further widen the gap between the top one percent and the rest of the population.” (Mazur, 2019, p. 289). Meaning that an increase in automation does not necessarily translate to higher wages for workers, widening the wealth gap. The paper *"Should Robots Be Taxed?"* by Guerreiro, Rebelo, and Teles (2022), assesses the implications of introducing a robot tax, discussing both the benefits and risks of the tax. The authors use an economic model to examine whether taxing robots is optimal and how it can impact income distribution. It distinguishes between two types of workers: routine workers, whose tasks are replaceable by automation, and non-routine workers, whose tasks benefit from automation. Their findings show that automation increases inequality by raising the wages of non-routine workers while reducing opportunities for routine workers. The authors argue that a robot tax can help reduce income inequality by decreasing the wage gap between these different types of workers, allowing the government to better support routine workers. The paper shows that automation increases output and tax revenue. Moreover, taking age differences into consideration, the authors also reached the conclusion that robot taxes should be higher in the short term and decline as time goes on. The authors believe that initially, the introduction of a robot tax serves to support older workers (routine workers) who aren´t able to change their careers. However, as these workers retire, the optimal robot tax gradually decreases until it eventually reaches zero. This happens in order to encourage younger workers to specialize in non-routine jobs, which benefit from automation (Guerreiro et al., 2022). Furthermore, in his paper regarding the optimal taxation of robots, Thuemmel (2023) argues that a tax on robots can help to reduce inequality, but it comes at the cost of distorting production efficiency. Thuemmel (2023) refers to the *Production Efficiency Theorem* created by Diamond and Mirrlees in 1971. This principle tells us that in an ideal world, all production decisions should not be influenced by taxation, as this ensures the most efficient use of resources. Despite this, Thuemmel (2023) believes that taxing robots can serve as a second-best solution in some cases. He suggests that when robots are expensive, a small subsidy can encourage adoption. As robots become cheaper and inequality rises, a small tax (0.5-1%) may help reduce wage inequality (Thuemmel, 2023). Lastly, Zhang (2019) views a robot tax as a good measure to reduce wage inequality. He explains that automation tends to widen the gap between skilled and unskilled workers because robots replace lower-wage jobs. That being said, Zhang argues that "robot taxation will improve wage inequality between the skilled and unskilled" (Zhang, 2019, p. 504). By making automation more expensive, the author argues that companies would be less likely to replace workers with robots, helping unskilled workers keep their jobs and get paid more. Meanwhile, wages for skilled workers might not grow as fast, reducing the inequality between the two groups.

Critics of a robot tax argue that it would create several unexpected negative consequences. The first one being discouraging innovation. The early 20th-century Schumpeter described innovation in capitalism as a process of creative destruction, where new technologies replace old ones. Both the creation of new opportunities and the destruction of existing jobs are clear in this process. The key challenge is finding the right balance between the two (Segal, 2018). A similar dilemma arises regarding the effects of the robot tax on innovation – does the introduction of a robot tax come at the cost of slowing down innovation? A robot tax increases the cost of adopting robots, making it more expensive for companies to invest in new technologies. This could slow down technological progress, reducing productivity and growth. Mazur (2019) argues that "a tax on robots is equivalent to a tax on innovation and is likely to hinder economic growth and overall prosperity" (Mazur, 2019, p. 280). Meaning that, for this author, a robot tax will most likely discourage investments in robots. The author argues that innovation is a key driver of economic growth and any measure that discourages it should not be followed. Abbot (2020) argues that while the idea of taxing robots may seem appealing at first, it could have negative consequences for technology. Abbott highlights that current tax laws favour automation by placing bigger taxes on human labour than on AI systems. This creates an incentive for businesses to automate, not only because it improves productivity, but also because it also reduces tax burdens. Other scholars further reinforce their concerns regarding innovation. Damijan et al. (2021) argue “that taxing robots would be a self-defeating act that would spur innovation and slow technological progress” (Damijan & Damijan, 2021). Kisska-Schulze and Mock (2021) are also against the robot tax as they argue that “it is now imprudent to tax innovation for fear of automation substitution” (Schulze & Mock, 2021, p. 301) and that “humans have adapted to innovative changes since primitive man. In modern cultures, each industrial revolution has added and subtracted human jobs” (Schulze & Mock, 2021, p. 306). Lastly, Prettner and Strulik (2020) provide a clear trade-off in their paper: while the robot tax can improve short-term income equality by providing compensation to low-skilled workers, it does this at the cost of less innovation. This conclusion can be reached as "the revenue raised by the robot tax increases income of low-skilled workers by 12.5%. Confirming Proposition 6, the robot tax depresses R&D and TFP growth. As a result, wages of high-skilled workers increase at a lower rate, which causes a slower expansion of high-skilled labour supply." (Prettner & Strulik, 2020, p. 261). Meaning that a robot tax can increase the income of low-skilled workers, therefore reducing inequality. However, it does so by reducing R&D, slowing productivity growth, and lowering the incentive for firms to innovate at the same time. Their findings show that even a “modest” robot tax would slow down the pace of R&D and economic growth.

Second, reducing incentives for skill development. Prettner and Strulik (2020) argue that while a robot tax could redistribute income to low-skilled workers in the short term, it would have negative long-term impacts. The main point they raise is that a robot tax reduces the profitability of automation, which consequently lowers incentives for companies to invest in R&D. Since R&D is the primary driver of innovation, any tax that discourages investment in automation could hurt innovation. Moreover, the authors refer to the term *skill premium*, which is the difference in pay between people with higher education and people without it. They argue that by reducing the *skill premium* with the introduction of a robot tax, it could lead to less and less people pursuing higher education since there is no incentive to. This decrease of high-skilled workers also weakens the capacity to innovate. Also, if companies are discouraged from adopting robots, the demand for skilled workers in fields such of robotics could decline. This, in turn, might reduce incentives for education, harming long-term innovation. Additionally, Dauth et al. (2021) assess how labour adjusts to automation, specifically focusing on industrial robots in Germany. While the authors don´t specifically mention a robot tax, they investigate job displacement effects and skill adaptation in response to robot adoption. The authors argue that young workers adjust their education choices with the increase of automation, shifting away from vocational training towards universities. The author´s findings suggest that the new jobs that arise from automation "pay higher wages, are characterized by a larger share of abstract instead of routine tasks, and a higher college share" (Dauth et al., 2021, p. 3106). Meaning that automation triggers a process of job reallocation and skill transformation. This pursuit of higher education by young workers is a good indicator for innovation since an increase of highly skilled workers, combined with an increase in output from universities, fosters more technological advancement. One can then conclude that both these authors clearly defend that innovation thrives on knowledge creation.

Third, increasing business costs and relocation. Implementing a robot tax could raise the monetary burden for companies, making them less competitive. Higher costs have the potential to push businesses to relocate to countries with better policies. This could have the opposite effect of what the tax intends. Chand et al. (2020) argue that imposing taxes on robots would be counterproductive, because "if tax incentives in R&D in automation are penalized or scaled back, then the taxpayer will simply move its activities to a jurisdiction that is ready to provide it with input or output incentives" (Chand et al., 2020, p. 742). Meaning that taxing robots would hurt R&D by discouraging investment in automation and incentivize companies to relocate. They point out that many governments around the world offer R&D tax incentives to support innovation and, a robot tax would contradict these efforts, making it harder for businesses to invest in new technologies. It wouldn´t make much sense for a government to offer R&D incentives to then go ahead and tax the very innovations they seek to encourage at the same time. Instead of imposing taxes that could stifle R&D, the authors defend policies that support the workers in transition through an education tax like already mentioned in chapter two. Furthermore, Mazur (2019) also notes that while the concerns behind robot tax are valid, a robot tax is not the right solution. A robot tax would discourage innovation by increasing costs for companies and weakening competitiveness, in the author´s own words: "a robot tax would increase the cost of robots, therefore reducing the incentive for companies to innovate and penalizing technological progress and productivity" (Mazur, 2019, p. 299). Much like Mazur, Robert Atkinson is of the opinion that the impact of a robot tax on innovation is negative, he views robot adoption as an important driver of productivity and global competitiveness. He highlights evidence that investment in robots has contributed significantly to GDP growth in different developed countries and argues that their adoption is a must for countries to remain competitive. Furthermore, "the productivity of R&D has been declining, making it harder to get innovation" (Atkinson, 2019, p. 6). Meaning that in the present day is much harder to achieve significant innovations than previously before, so governments shouldn´t make it even harder. Lastly, Damijan et al. (2021) also argue that taxing robots may lead to unintended consequences, such as companies relocating their operations to other countries, resulting in a loss of competitiveness and tax revenue.

6.CONCLUSION & DISCUSSION

The goal of this dissertation was to map the state of knowledge regarding the literature on robot tax and innovation. To achieve this, a scoping review was conducted in two phases. The first phase a bibliometric analysis to map the research landscape. The second phase focused on a qualitative exploration of the topic.

The methodological approach adopted in this dissertation has provided good insights into the state of the debate. However, it also presents some limitations, the major one being the limited number of publications available. Additionally, the little existing literature is quite diverse which complicates efforts to establish consistency, reinforcing the need for further research to enhance the debate. Another limitation is the lack of research regarding the long-term effects of robot taxation, particularly real-world case studies.

This dissertation put forward several insights. As robots transform industries, the debate around taxing robots is of upmost importance, with concerns over economic growth, job displacement and technological progress. The findings reveal divided opinions regarding its introduction. While some argue that a robot tax could reduce inequality, others argue that it could harm productivity and growth.

Through the bibliometric analysis, this study assessed how the academic landscape has addressed this topic. This analysis provided insights into how research has evolved, and it showed a growing interest in the robot tax. However, it became clear that despite the growing interest in the robot tax, there is not a proportional interest on innovation.

From the findings of chapter five, some scholars argue that a robot tax acts as a tax on innovation itself, discouraging companies from investing in automation and slowing down productivity. Their concerns are based on the idea that robots drive efficiency, growth, and global competitiveness. Moreover, the empirical findings show that the tax raises automation costs, discouraging R&D and consequently innovation. And, while it may reduce inequality, it also lowers incentives for higher education, therefore hindering long-term innovation. Additionally, firms may relocate to avoid taxation, reducing competitiveness.

To conclude, the findings highlight future research areas, emerging both from methodological limitations and empirical insights. The major limitation identified was the restricted number of publications available. Research on the robot tax mainly assesses its economic consequences, failing to explore its relationship with innovation. This type of research is of upmost importance and should be pursued in the future.

Moreover, empirical findings also suggest important research directions. One important issue is the trade-off between fostering innovation and reducing inequality. Perhaps future studies should explore alternative taxation models to assess whether it is possible to mitigate inequality without discouraging innovation. Additionally, concerns were raised about how robot taxation may reduce incentives for higher education. In this light, further research should investigate how policies can better support adaptation, possibly through reskilling programs and education incentives. Lastly, due to the fear of relocation, it could also be interesting to assess the fiscal strategies that would be necessary to ensure international coordination with the introduction of a robot tax.

Finally, I would like to finish by saying that the impacts of a robot tax on innovation will probably depend on how said tax is designed. Its key that policymakers create policies that encourage R&D while tackling inequality and job displacement. Meaning that future studies should focus on tackling these gaps to help provide some guidance.

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8. APPENDICES

Search Strategy	**Data base**	**Outputs**
(TITLE ((robot* OR automat*)) OR KEY ((robot* OR automat*)) AND TITLE ((tax OR taxation OR (fiscal AND polic* OR tax AND polic*))) OR KEY ((tax OR taxation OR (fiscal AND polic* OR tax AND polic*))))	Scopus	649 outputs (571 outputs after the year and language filter)
(TI= (robot* OR automat*) OR AK= (robot* OR automat*)) AND (TI= (Tax OR taxation OR fiscal Polic* OR tax polic*) OR AK=(Tax OR taxation OR fiscal Polic* OR tax polic*))	WoS	228 outputs (184 outputs after the year and language filter)

Table 3. Syntax table of search

Criteria	**Include**	**Exclude**
Title	Must include references to both:	Titles that:
	Robotization/Automation: Only terms like “robot*,” and “automat*,”	Refer to AI, digitalization, big data, or digital technologies without mentioning robots/automation
	Taxation/Fiscal Policy: Terms like “tax,” “taxation,” “fiscal polic*,” “tax polic*,” or related fiscal mechanisms	Mention robots/automation in relation to employment, management, or administration without any tax/fiscal reference

Abstract	Must establish a connection between robotization/automation and taxation/fiscal policy	Abstracts that lack any clear connection between robotization/automation and taxation/fiscal policy
	Indirect links, such as technological unemployment, inequality, or universal basic income (UBI), are acceptable	Articles using terms like "automat*" in unrelated contexts (e.g., "automatic stabilizers" or "automatic exchange of information)
Time Frame	Articles published from 2000 to 2024	Articles published before 2000
Language	Only articles published in English	Articles not published in English
Publication Type	Grey literature, articles, books, and reports are included	

Table 4. Inclusion and exclusion criteria

Metadata	Description	Missing Counts	Missing %	Status
AU	Author	0	0.00	Excellent
DT	Document Type	0	0.00	Excellent
SO	Journal	0	0.00	Excellent
LA	Language	0	0.00	Excellent
PY	Publication Year	0	0.00	Excellent
WC	Science Categories	0	0.00	Excellent
TI	Title	0	0.00	Excellent
TC	Total Citation	0	0.00	Excellent
C1	Affiliation	8	7.92	Good
AB	Abstract	13	12.87	Acceptable
DE	Keywords	26	25.74	Poor
RP	Corresponding Author	27	26.73	Poor
DI	DOI	30	29.70	Poor
ID	Keywords Plus	59	58.42	Critical
CR	Cited References	101	100.00	Completely missing

Figure 10. Data quality of merged data bases

Year	Average number of total Citations per Article	Total number of articles published	Average number of citations per year since publication	Citable Years
2000	1,50	2	0,06	26
2003	0,00	1	0,00	23
2007	0,00	1	0,00	19
2009	3,67	3	0,22	17
2010	1,00	2	0,06	16
2012	6,00	3	0,43	14
2013	0,00	1	0,00	13
2015	0,00	1	0,00	11
2017	7,00	4	0,78	9
2018	9,50	2	1,19	8
2019	5,91	11	0,84	7
2020	8,18	17	1,36	6
2021	1,57	7	0,31	5
2022	5,44	16	1,36	4
2023	1,38	16	0,46	3
2024	0,14	14	0,07	2

Table 5. Average citations per year

Cluster Label	Words
efficiency	efficiency; equity; fiscal sustainability; fourth industrial revolution; income inequality
automation	automation; robots; taxation; artificial intelligence; robot tax; tax policy; inequality; digital economy; technological unemployment; employment; jobs; universal basic income
economic growth	economic growth; fiscal policy; robot taxation; wage inequality; welfare
tax	tax; digitalization; innovation; robot; robotics; rpa
growth	growth; optimal taxation; education

Table 6. Cluster label author keywords