# Effects of Corn Ethanol on US Retail Gasoline Prices: A PRISMA-Guided Systematic Literature Review and Bibliometric Analysis

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This paper seeks to offer a comprehensive overview of contemporary literature about the effects and contributions of corn ethanol on retail gasoline prices in the United States. A systematic literature review adhering to the PRISMA statement was conducted to address four research questions: (1) What are the primary characteristics of the literature concerning the impact and contributions of ethanol on US retail gasoline prices? (2) What are the primary clusters of articles detected in the reviewed literature? (3) What was the effect of the Volumetric Ethanol Excise Tax Credit/Renewable Fuel Standard (VEETC/RFS) mandate on the price of gasoline, and what are the most common ways to figure this out in the literature? (4) What are the primary trends and potential new research avenues for this body of literature? The characterization of the sample led to the identification of driving themes, including energy policy, costs, price dynamics, trade, and the energy market. The sample also revealed three primary clusters: (i) the effects of biofuels on commodity prices and overall price dynamics; (ii) the influence of public policies on the adoption of ethanol and the adaptability in creating fuel blends; and (iii) the environmental consequences of biofuels. The main finding in the literature that was looked at is that adding ethanol lowers the price of gasoline at the pump. Estimates range from no effect to about 10% off the price of gasoline. Lastly, the most important area of research is the effects of biofuels on commodity prices and the overall price dynamics. This is also the trend represented by the proposed research agenda.
**Keywords:** Biofuels; Corn; Ethanol; Gasoline; US Retail Prices; Systematic Literature Review

**Introduction:**

In the last several years, the biofuel sector has grown a lot around the world, especially in the US, the EU, and Brazil. In the previous century, agricultural economists and politicians were first interested in biofuels as a way to replace fossil fuels and make energy more secure. Later, they also became interested in biofuels as a way to deal with climate change, food security, and rural development [1]. Since the beginning of the 21st century, biofuels have been a hot topic in the public eye and in research on agriculture and energy. This has led to two main themes. The first major body of literature deals with food security and crop pricing [2][3]. This is because the main function of agricultural produce has always been to feed people. The second one is about ecology and the environment [4][5][6][7]. It talks about things like greenhouse gas emissions (GHG), how land and water are used compared to just utilizing fossil fuels, and leaving land for growing food or providing environmental services [8].

Most of the research on commodity food prices is about econometric analysis, which looks at how food and biofuel prices are related and how they move together. The primary issue is that utilizing agricultural production as a feedstock for biofuels instead of for food consumption increases food prices and leads to nutritional crises, especially in low-income

nations. The food crisis from 2008 to 2010 led to a lot of research on this subject [9][10][11][12]. Most Studies show that the link between food and ethanol costs is not very strong. However, both food and fuel prices do have an effect on ethanol pricing. Reference [13] provides an exhaustive analysis of studies and rigorously evaluates their findings. The Authors of [13] contend that conventional time-series analysis inadequately reflects the influence of biofuels on food, asserting that the impact is significantly heterogeneous across various crops and geographical regions. The review contends that the influence of biofuels on food commodities is, in reality, less significant than that of economic expansion and may be effectively mitigated by the utilization of genetically modified crops [14].

[15] present a meta-analysis of estimations about the impact of corn-ethanol on corn prices, indicating that a one billion gallon increase in corn-ethanol production results in a three to four percent increase in corn prices. [16] subsequently offers a comprehensive analysis of the literature akin to ours, examining the impact of biofuels' energy demand on agricultural commodities, whereas our focus ison the comparatively under-researched influence of ethanol on gasoline pricing.

[17] recently looked at how the Renewable Fuel Standard (RFS) program affects the environment. This program is the main reason why biofuel production has gone up since 2005, and even more so since the program was expanded in 2007. [17] found that the mandates led to more fertilizer use and less diversity in US soil because they encouraged less rotation in favor of growing maize. This, in turn, led to a significant increase in GHG emissions. [17] also said that the increasing demand for corn caused the prices of soybeans and wheat to go up, and they disagreed with the idea that present corn-ethanol production could help fight climate change. This study, along with [18][19], offers a robust critique of the RFS program, which is succinctly encapsulated in [20]. The goal of this study is to look at the best current research on how maize ethanol affects and contributes to US retail gasoline pricing. Studies contend that although corn-ethanol generates profits for corn farmers and ethanol producers, it incurs significantly higher costs for US taxpayers through the funding of subsidies, elevated gasoline and food prices, and the overall substantial expenses associated with climate change and other environmental degradation, including impacts on water and air quality. Research yielded conflicting outcomes compared to the meta-analysis in [21]. Look at the GHG discussion in [22] as well. One major difference between the two studies is that the US went from being a net oil importer to an exporter in 2020. According to [20], this makes the RFS program less necessary.

We view the extensive discussion above as indicative of both the complexity of the biofuel subject and the change of outcomes over time. This article contributes to the discourse on price effects by examining the literature on the influence of ethanol blending into gasoline in the United States. The Discussion around biofuels is still going on and changing quite quickly and in big ways. extensive discussion above as indicative of both the complexity of the biofuel subject and the change outcomes over time. The article contributes to the discourse on price effects by examining the literature on the influence of ethanol blending into gasoline in the United States. Our comprehensive Literature evaluation delineates the methodologies employed in the research and their significance in estimating the effects of ethanol. The goal of this study is to look at the best current research on how maize ethanol affects and contributes to US retail gasoline pricing. We suggest four research questions (RQ) to help us reach this goal:

What are the primary points that the literature makes on how ethanol affects US retail gasoline prices?

What are the primary clusters of articles detected in the reviewed literature?

What effect did the Volumetric Ethanol Excise Tax Credit/Renewable Fuel Standard (VEETC/RFS) mandate have on the price of gasoline? What are the main ways that people get into the literature used to figure this out?

There are four parts to this article: key patterns in this literature, and what new research possibilities might there be? Four parts to this article. In Section 2, we talk about the method we used and the descriptors. The approach and the descriptors are explained in detail for each phase. Section 3, which is split into four parts, shows the results and has a commentary. (a)In the end, Section 4 gives the conclusions and suggestions that go with them.

**Materials and Techniques**:

The systematic literature review (SLR) is a structured review method that lets other people repeat and confirm the study that was done and follow the same path that was chosen for the research [23]. This distinguishes SLR from a conventional exploratory review, minimizing researcher subjectivity and yielding a scientific, transparent, and replicable methodology [24]. In the systematic literature review (SLR) presented in this study, we adhered to the guidelines of the PRISMA declaration, along with five phases advocated in the literature [25]:

Systematic Literature Review (SLR) is a structured review method that lets other people repeat and confirm the study that was done and follow the same path that was chosen for the research [23]. conventional exploratory review, minimizing researcher subjectivity and yielding a scientific, transparent, and replicable methodology [24]. systematic literature review (SLR) presented in this study, we adhered to the guidelines of the PRISMA declaration, along with five phases advocated in the literature [25]:

Make research questions that can help the study.

Find the research in the literature that is most useful to you.

Look at how good and useful the articles are.

Find and summarize the scientific proof.

Make sense of the results you found.

In basic words, SLR is a methodical procedure made up of three steps: input (i), processing (ii), and output (iii) [26][27]; see Figure 1 for an example. We set the research challenge and goals during the input phase. We look for research in the databases, make search strings, and set exclusion or inclusion criteria throughout the processing phase. We then use these to apply filters that help us analyze the results. After that, we write down the results. During the output step, we make tables and figures that show the results we got.

Picture 1. A model for doing a systematic literature review. Adapted from [27][28]. Energies 16 00428 g001 model for doing a systematic literature review.

This part is all about going into detail about how we did the SLR that helped us answer the research questions (RQ) from the last part.

We define the research problem and its goals, as well as studies that are pertinent to the literature, in the input phase. We determine the primary keywords of the publications that would enhance the discourse around the suitable search strings for conducting the SLR. 1. 2. 3. The title of the paper, the keywords, or the abstract could be "gasoline price," "fuel price," "gas price," "petrol price," "petroleum price," "retail price," "gasoline market," "fuel market," "gas market," "petrol market," "petroleum market," "petroleum product market," "wholesale," or "price support. “essential to recognize that the submitted research questions facilitate the direction of the research development and the presentation findings. Scopus database (from Elsevier) was chosen for this since it is widely used and well-accepted. Use the search strings below, using the Boolean logic "and" between levels (1.), (2.), and (3.). sign " makes sure that the words are in the right order. Changes were made to make the words multiple and singular. Title: "ethanol," "biofuel," "bioethanol," or "renewable fuel" title of the paper, keywords, or abstract should include "US" or "US," "USA," "USA," "United States," "Midwest," or "corn."

Title of the paper, keywords, or abstract could be "gasoline price," "fuel price," "gas price," "petrol price," "petroleum price," "retail price," "gasoline market," "fuel market," "gas market," "petrol market," "petroleum market," "petroleum product word "corn" in the geographic part of the filter to find papers about corn ethanol that don't have the US (or something like it) in title, abstract, or keywords for some reason. bibliometric analysis software VOS viewer and the R package Bibliometrix [29]; for evaluation, synthesis of search strings produced 202 publications in the Scopus database when searched in September 2022. List down to 130 articles after reviewing the title, abstract, keywords, and search results. This was because several of the articles in the first sample were not relevant to the research. Second filter after reading the data and conclusions for the first time, and we got a sample of 112 articles. Finally, we reviewed all of the articles and cut the sample down to 109. Energies 16 00428 g002 Figure 2. Summary of articles that are filtered after reading. We highlight the most essential reasons for not including someone in the processing phase: Research from international contexts (including Brazil, Argentina, Mexico, the EU, Thailand, etc.), where ethanol is predominantly derived from sugar-based feedstocks.

Assessment of various biofuel feedstocks (cellulosic, lignocellulosic, agricultural biomass, oilseeds, etc.);

Studies concentrated on alternative matters (effects of food prices, greenhouse gas emissions, ethanol blending, governmental influence, and perceptions regarding subsidies, etc.);

Studies of various areas, such as chemistry, production technology, and so on.

The output phase is where we analyze and put together the results. In the next part, we go into more depth about what we mean by this.

**Table 1.** Inclusion and Exclusion Criteria Applied in the SLR Process

| Stage | Criteria Applied | Initial Results | Final Sample After Stage |
|---|---|---|---|
| Database Search | Scopus with defined Boolean strings | 202 | - |
| Title/Abstract/Keywords | Relevance to US corn ethanol & gasoline prices | 130 | - |
| Full-Text Screening | Must address price effects or policy impacts | 112 | - |
| Final Quality Check | Quantitative/qualitative relevance to RQs | 109 | 109 |

**Results and Talk:**

**Characterization of Samples:**

To address RQ1 (what are the primary characteristics of the literature concerning the effects and contributions of ethanol on US retail gasoline prices), we begin with the temporal distribution of the articles. Figure 3 shows how the articles in the sample are spread out over the years. This figure also shows the proportion of the sample in the general literature on the issue, which is the ratio of publications connected to the US to the World when search string (ii) is deleted and there are no limits by country or area. It is crucial to point out that people in the US are more interested in the topic than people in other countries. We can see that people were more interested in the issue from 2009 to 2012; the next analysis will demonstrate that it is still very essential and useful to scholars.

**Table 2.** Top Journals Represented in the Sample (Minimum 3 Articles)

| Journal Name | Number of Articles | Primary Focus Areas |
|---|---|---|
| Energy Policy | 12 | Policy impacts, RFS, subsidies |
| Energy Economics | 9 | Price dynamics, econometric modeling |

| | | |
|---|---|---|
| American Journal of Agricultural Economics | 8 | Commodity prices, biofuels & food |
| Journal of Environmental Economics and Management | 5 | Environmental consequences, GHG emissions |
| Biomass and Bioenergy | 4 | Production technology, lifecycle assessment |

**Table 3.** Most Cited Articles in the Sample and Their Key Contributions

| Rank | Lead Author(s) & Year | Citations | Core Contribution | Relevance to RQ3 (VEETC/RFS Impact) |
|---|---|---|---|---|
| 1 | Hill et al. (2006) | >2000 | Environmental & economic costs/benefits of ethanol | Baseline comparison |
| 2 | Demirbas (2008) | >800 | Global biofuel policy & economy overview | Policy context |
| 3 | Zilberman et al. (2013) | High | Meta-analysis of biofuels on food prices | Indirect price effects |
| 4 | de Gorter & Just (2009) | High | Economics of blend mandates & tax credits | Direct VEETC/RFS modeling |

**Table 4.** Summary of Quantitative Estimates on Ethanol's Effect on US Retail Gasoline Prices

| Study (Year) | Model Used | Estimated Price Effect of Ethanol | Key Finding / Range |
|---|---|---|---|
| Multiple (various) | General/Partial Equilibrium | -0% to -10% | Most common: modest reduction |
| de Gorter & Just (2009) | Tax credit & mandate model | Tax credit lowers fuel prices | Self-financing in short term |
| Others (meta-analysis) | Various econometric | 3–4% corn price increase per billion gallons | Indirect gasoline effect via corn |

**Energies 16 00428 g003:**

Figure 4 shows the most important scientific publications that include at least three articles in our sample. Energy Policy, Energy Economics, and the American Journal of Agricultural Economics are the journals with the most articles. There are a lot of journals that focus on energy, agriculture, and other topics, such as ethanol and biofuels. The Journal of Environmental Economics and Management is also on the shortlists, which is interesting because it covers a wider range of topics than only the ones listed above.

**Energies 16 00428 g004:**

Figure 5 shows the fourteen articles in the sample that were cited the most. The average citation per year displays how citations have changed over time and explain the data in a way that shows the most recently published publications. The writers [6] and [7] dominate the figure, exceeding 2000 and 800 citations, respectively. [13] and De Gorter and Just [30] are also highly important studies, with more than 140 citations apiece.

**Energies 16 00428 g005:**

**The most important and most mentioned publications in the sample:**

Because the publications in Figure 5 have been cited so many times, we will give a short synopsis of their contents below. thesis encompass various domains, including current linkages and the influence of biofuels on commodity food prices [13][31][32], the environmental consequences of biofuels , and policy considerations and their ramifications.

The research conducted an environmental and economic evaluation of energy expenses and the advantages of biodiesel and ethanol biofuels. The study assessed corn ethanol and soybean biodiesel by life cycle evaluation. The primary conclusion is that biofuels

exert a reduced environmental impact in comparison to fossil fuels. But no biofuel could replace oil without hurting food supplies, and subsidies are needed to make biofuels profitable.

The document delineates definitions, specifications, compositions, production data, applications, and future outlooks pertaining to biofuel sources, biofuel policy, biofuel economy, and worldwide biofuel forecasts. The research examines potential scenarios about the effects of biomass on the global economy.

The authors contend, employing a conceptual model and preliminary estimations, that ethanol subsidies are self-financing in the short term, and that the development of biofuels from food feedstock will significantly affect food costs more than energy prices.

The study utilized time series econometrics to evaluate the influence of biofuels on commodity food prices. The primary conclusion is that the price of ethanol rises concurrently with the escalation of corn and gasoline prices. The research also discovered a favorable correlation between ethanol prices and the prices of sugar and oil in equilibrium.

The paper provides a conceptual framework for studying the economics of a biofuel mandate and assesses the economic consequences of its conjunction with a tax credit. The findings demonstrate that tax credits yield reduced fuel prices compared to a mandate for equivalent biofuel production levels. If tax credits are used with mandates, they would lower the cost of using fossil fuels instead of biofuels, which would go against the goals of the energy strategy.

The study looked at how prices and transmission patterns changed in the US ethanol business from 1990 to 2008. The study examines the correlations among corn, ethanol, gasoline, and oil prices. The data show that there is a strong link between food prices and energy.

The paper evaluates the effects of biofuel production and various supply and demand factors on escalating food costs through a comprehensive literature analysis. The findings demonstrate that biofuel production played a lesser role in the escalation of food commodity prices until 2008.

The study looked at how biofuels affect the environment. The findings demonstrate that ethanol derived from biomass has environmental and economic advantages and is regarded as a cleaner and safer substitute for fossil fuels.

The research suggests a multivariate modeling framework to evaluate both short-term and long-term correlations among the prices of maize, soybean, ethanol, gasoline, and oil. The paper examines whether these associations evolve. The findings demonstrate that, in recent years, there have been no enduring correlations between agricultural commodity prices and fuel costs.

This study presents a framework to evaluate the impacts of a tax exemption on biofuel consumers and the interaction effects with a price-contingent agricultural subsidy. The authors discovered that the tax credit diminishes the expenses associated with the loan charge program; however, this escalates the expenditures of the tax credit.

This study examined farmers' preferences between a direct subsidy for maize production and a subsidy for the ethanol derived from corn. The research employed a vertical model encompassing ethanol, byproducts, and corn, concluding that farmers benefit more from direct corn subsidies.

The authors advocate for the utilization of economic models, particularly those employed in the US, to evaluate the impact of biofuel regulations on petroleum product markets and their implications for greenhouse gas emissions.

The article suggests a literature review and a meta-analysis approach to evaluate the effects of ethanol policies on corn prices from 2007 to 2014. The findings suggest that an augmentation of the corn ethanol mandate may result in a 3 to 4 percent rise in corn prices for the upcoming year.

The study assessed the corn ethanol sector, its effects on food prices, and the function of biotechnology in the US using a literature review. The scientists discovered that biotechnology exerted minimal influence on the biofuel sector.

In Figure 6, the Citation Tree map shows hierarchical data (organized tree) as a series of stacked rectangles. We look at several citations for each article. The size of each rectangle is based on how many times the manuscript has been cited in the sample. This map is meant to show how the number of citations for the two most cited papers in the sample is different from the number of citations for the other studies in the sample.

**Energies 16 00428 g006**

The difference displayed in Figure 6 is a good reason to leave out the studies suggested for Figure 7, which aims to highlight how the most cited publications in the sample are cited over time, adding to the information given in the list above. For instance, have a lot of absolute citations, but their influence has waned in more recent publications because the number of citations each year has gone down. A study is another example. It got a lot of citations in 2011 and 2012, making it one of the most cited in the sample. But it hasn't been cited much in the last few years. At the same time, other authors, have remained important in contemporary works. Finally, have stood out in the last few years.

**Energies 16 00428 g007:**

Figure 8 shows the authors or co-authors (individually) who are most representative of the sample and have the most publications. This is different from the previous graphs, which were about publications. Zilberman D. is one of these. & Thompson W. stood out, with ten and eight pieces each, respectively. Hochman G. and Rajagopal D. are each mentioned in seven different papers in the sequence.

**Energies 16 00428 g008:**

The tree-field plot in Figure 9 demonstrates how the most common journals in the sample, the main authors, and the keywords are all connected. Thompson is one of the most important authors in the sample. His work has been published in journals including Energy Policy, Eurochoices, and The Economics of Alternative Energy Sources and Globalization. In his research, this author has used terminology like "ethanol," "greenhouse gas emissions," "renewable fuel standard," "biofuel mandates," and "gasoline." Zilberman, another important scholar on the subject, has written for journals like Agricultural Economics, the American Journal of Agricultural Economics, and Agbioforum. "Biofuels," "greenhouse gas emissions," "energy prices," "energy policy," "climate change," and "corn ethanol" are some of the most important words in his work.

**Energies 16 00428 g009:**

Figure 10 shows the thematic mapping, which makes it possible to see different kinds of themes. In the thematic map, we employ keywords from the sample articles. These keywords are defined by a semi-automated process that Thomson Reuters experts are in charge of. This approach can capture the substance of an article with more variety and depth

**Energies16 00428 g010:**

The upper right quadrant of Figure 10 shows more developed subjects (density) and relevance (centrality) in the literature. "Energy Policy" and "costs" are two of the most important topics. As anticipated, another significant topic identified in this study was "United States," characterized as one of the terms in the search strings. Other important subjects are "price dynamics," "commerce," and "energy market." In the lower left quadrant, you can find themes that are going away or coming up. The findings of this research indicate that the subject of "energy utilization" is an emerging area of study. In the lower right quadrant, you can see several basic themes. These topics are broad ideas that apply to all of the disciplines of research. From our sample, they include "ethanol," "biofuel," "zea mays," "biomass," "carbon dioxide," and "biodiesel." Lastly, the upper-left quadrant reveals topics that are quite

dense but not very important to the sample or the field as a whole (low centrality). The themes that stand out the most include "agriculture," "economic development," "energy independence," "energy security," "Environmental Protection Agency," and "fuel prices."

We used the VOS viewer software to make Figure 11 in order, and it is based on the co-occurrence information of the authors' keywords. The size of the nodes in this figure shows how many times the articles in the sample used these keywords. The lines linking the nodes show that the keywords were used in the same publication, and the colors show the year of publication. Even though the search phrases didn't include them, the topics "Renewable Fuel Standard" and "policy" are still very relevant. This network also helps find popular topics in the area, like "retail fuel spreads," "pass-through," "fuel markets," "E85," or even "energy prices" and "meta-analysis."

**Energies 16 00428 g011:**

Finally, Figure 12 was created using a multiple correspondence analysis, which is a way to look at the keywords and articles in the sample in a more general way. The conceptual structure map shows groups of articles that talk about connected ideas.

**Energies 16 00428 g012:**

You can figure out what this picture means by looking at how the points are spread out and where they are on the dimensions. The more alike the keywords are in terms of distribution, the closer they are in the figure. The figure shows how to find new latent variables by grouping category variables into clusters. This is how we find two separate clusters. The first cluster (in red) looks like it is more important because it is bigger and more central to the dimensions. The red cluster has essential words like "price dynamics," "commodity price," "gasoline prices," "blending, "taxation," and "subsidy system." These are all concepts that have to do with the price and market dynamics of biofuels in the US. The second cluster (in blue) highlights words like "economics," "energy security," "public policy," and "gas emissions" as terms that are related to making public policies for the use of biofuels and their effects on the environment. This division aligns with the exploratory and introductory analysis presented in the Introduction.

**Main Cluster Structure:**

To address RQ2 (what are the primary article clusters discovered in the reviewed literature?), content analysis, together with mapping and clustering techniques, was employed, as they are commonly used in systematic literature reviews.

Clustering algorithms can be used to make a map that shows the areas that match the clusters of nodes that were found. We used VOS viewer software to build a bibliographic coupling network. Figure 13 shows the graphical findings and the way prices change over time, as well as the effects of biofuels on the environment.

Vital to remember that the clustering method was developed using coincidental references. This means that articles in the transition region between the main clusters can be used to evaluate topics that are common to more than one cluster, such as authors of the first group, natural gas prices and quantities, with particular emphasis on the implications of the ethanol tariff, mandates, and tax credits.

Looked at the situation in North America and how the increase in corn-ethanol production affects the price of natural gas. The findings show that the price of natural gas can go up by as much as 0.25% and 0.5% in the first and second scenarios, respectively. The findings showed that corn output went up. The authors used a two-stage least squares structural model to forecast two scenarios: (i) the disregard of current policies, including tariffs, tax credits, and mandates; (ii) the establishment of ethanol production solely for the utilization of mandatory additives.

Conducted a study examining the influence of ethanol policy on which will likely cause natural gas costs to go up as well.

Examined the correlation between food and fuel markets. Authors say that the ethanol market has a strong relationship between the corn and energy markets. They also say that the price of ethanol goes up when the prices of maize and gasoline go up. The study finds that the prices of ethanol, sugar, and oil are all linked beneficially. The authors discovered evidence indicating that pricing correlations are diminished when the RFS is mandatory. The study in this group, which looks at how the RFS affects fuel prices and compliance costs. The RFS did not have a big effect on the cost of gasoline and diesel at the pump. Looking at the pricing link between ethanol and gasoline, as well as between corn and gasoline, in both required and non-mandatory RFS situations. Effects of public policies on the use of ethanol and the ability to change how fuel is mixed. The factors influencing demand for E85 are essential for formulating effective policies to promote E85 and for creating models that forecast its sales in the US. The article proposes a regional market model to quantify the effects of prices on various market characteristics.

On the second cluster discovered, contend that in this manner, the authors assessed the responsiveness of aggregate demand for E85 to the prices ofE85 and gasoline, as well as the comparative availability of E85 relative to gasoline. They concluded that the most recent data facilitates a more accurate estimation of demand and suggest that the price elasticity of E85 is significantly greater than previously assessed.

Transmission of the E85 subsidy to retail fuel prices in the United States. The demand for gasoline and diesel. Authors contended that the RFS depends on taxes and subsidies to be transmitted to consumers to increase the demand for biofuels and decrease to 75% of the E85 subsidy was transferred to consumers, with the pass-through period lasting around 6 to 8 weeks, influenced by the market structure of retailers, affecting both the speed and extent of the pass-through.

Conducted a quantitative analysis to evaluate the risks associated with price fluctuations for biofuel producers in a deregulated market. The writers came up with a list of risk management measures that can be used to defend the biofuels business.

From another Angle, looked at whether the US can accomplish the RFS goals without a way to enforce them. The Authors suggested a parametric examination of ethanol utilization within the domestic automotive sector. The Results show that the RFS program's goals of cutting down on fossil fuel use and, as a result, GHG emissions may be met by making cars more fuel-efficient.

Effects of Biofuels on Environmental Factors examined how more biofuels being made might affect the markets for food and gasoline. They included this information in the third cluster.

Examined how more biofuels being made might affect the markets for food and gasoline. They included this information in the third cluster. Authors employed a hybrid lifecycle assessment within a multi-regional input-output (MRIO) framework, present biofuel production creates a contradictory dynamic between food and fuel, resulting in elevated food costs and diminished gasoline prices. The study concluded that agriculture must supply food and fuel, necessitating continuous enhancements in its output. crucial role in facilitating this enhancement. utilized four scenarios to evaluate the capacity of biofuels to reduce emissions in the UK. conducted a time-series analysis of the five principal agricultural commodities, cultivated area, and the price of crude oil to examine the effects of land use changes resulting from biofuel production in the US. Authors assert that the markets for crude oil and cultivated agricultural land are mutually reliable, concluding that to meet the emission reduction targets set by the Low Carbon Transition Plan (LCTP), biofuels must comprise 23.8% of the transport fuel market by 2020.

Piroli et The Authors assert that the rise in biofuel production induces alterations in land utilization, which in turn leads to the substitution of food items with crops designated for biofuel production.

Fuels with biofuels would affect carbon dioxide emissions in the US transportation industry. The author posts that ethanol serves as a substitute for oil and a complement to natural gas, whereas natural gas functions as a substitute for oil. The author says that the switch from fossil fuels to biofuels due to price is an important component in determining how much carbon dioxide biofuels will release. Look at our sample to see how changes, or lack of, to ethanol mandates have affected gas prices.

**Estimates in Numbers:**

Now we will change; we extracted 20 papers that present numerical findings pertinent to our study subject. We talk about the methods, approaches, and models that were employed in the articles we just spoke about. First look, we saw that a lot of the publications in our collection are also in the meta-analysis study. chosen to incorporate four absent articles that were not part of our sample but were featured to enhance our comprehension of the numerical interpretation of the results. important to note that these four studies are pertinent and acknowledged within the study domain; yet, they were not located in the search since they were absent from the Scopus database.

Figure 14 illustrates the models that are used the most. General and partial equilibrium models, biofuel and environmental policy analysis models (BEPAM), and supply–demand models are the most used.

**Energies 16 00428 g014:**

Some studies, like looked at a lot of various possible results based on different situations. For example, they looked at what would happen if there were no rules for the baseline pricing or if VEETC or RFS or both were put in place. The outcome changed by 1–2 percentage points. Other studies, only looked at the RFS ethanol mandate and how it affected gasoline prices. In total, we found 13 papers that give us accurate numbers for the response to our research question RQ3, which was about how the VEETC/RFS mandate affected the price of gasoline and what the major ways to calculate it are in the literature. Table 1 shows detailed information on the papers in our sample that came from the SCOPUS database. Table 2 shows the four papers that were not in the SCOPUS database. Table 1. Articles mostly talk about the Volumetric Ethanol Excise Tax Credit (VEETC) from the American Jobs Creation Act of 2004 and the Renewable Fuel Standard for corn ethanol from 2007 as the main reasons why gasoline prices have changed. Studies, looked at a lot of various possible results based on different situations. For example, they looked at what would happen if there were no rules for the baseline pricing or if VEETC or RFS or both were put in place. The outcome changed by 1–2 percentage points. Studies, only looked at the RFS ethanol mandate and how it affected gasoline prices.

Found 13 papers that give us accurate numbers for the response to our research question RQ3, which was about how the VEETC/RFS mandate affected the price of gasoline and what the major ways to calculate it are in the literature. 1 shows detailed information on the papers in our sample that came from the SCOPUS database. Table 2 shows the four papers that were not in the SCOPUS database.

This section lists publications that give numbers on how ethanol affects the price of fuel. The first column shows the publication, and the second column shows the time period that was looked at. The third column tells you what model was employed, and the Relation column tells you if ethanol and gasoline are thought to be substitutes (Sub), complements (Comp), or perfect substitutes (pSub).

Table 2. This table highlights the publications in the analysis that looked at how ethanol affects fuel prices or welfare. The first column shows the publication, and the second

column shows the time period that was looked at. The third column tells you what model was used. The Relation column tells you if ethanol and gasoline are thought to be perfect or imperfect equivalents, and the Results column gives a summary of the study.

The most common outcome is that adding ethanol to gasoline lowers the price at the pump. But there is no clear agreement on the discount being offered, not even in terms of how much it is. Figure 15 shows that the estimates range from no effect to a discount of over 10% on the price of gasoline.

**Energies 16 00428 g015:**

Address RQ4 (what are the primary trends and research possibilities within this literature?), we suggest a potential open research agenda informed by the findings of our systematic literature review (SLR). The phrase bioethanol has been present in the studied sample since 2012 and continues to be relevant, particularly in conjunction with the term's "commerce" and "energy market." This indicates that this type of study remains significant to current research. 10 (thematic map) supports this assertion by showing the main topics of the area covered. These themes include biofuels supply chains, transportation biofuels, and the challenges of budget control and cost management, both in production and in the oversight of the biofuels supply chain. Also, looking at how topics change over time can help find research opportunities that deal with controlling greenhouse gas emissions and other environmental and climate issues.

Figure 11 (keyword co-occurrence map) supports earlier comments about research patterns and opens up new areas for research on retail fuel spreads and the composition of E85.

Figure 12 (conceptual structure map) also shows areas where more research is needed on public policies that deal with climate and environmental challenges and energy security. Sustainable development, pricing dynamics, blending, demand analysis, and biofuel production are examples of topics that are more central to the field, which means they are more likely to be studied.

What is absent from the terms we found in our search shows that there is a clear research opportunity to fill a significant gap in the literature. It is a matter of electromobility. The examination of the interaction between biofuels and electric vehicles should be categorized within the "environmental" cluster, which is cluster 3 in Figure 13. As we said before, this "environmental" cluster comes before the other two clusters for a short time. This shows how the focus has changed from a strong belief that biofuels have a positive effect on the environment to a more dubious view of this effect. Also, the lack of a link between biofuels and electric cars is because electric cars have just recently been popular, which is not the same time as the early biofuel literature in cluster 3 of Figure 13. The study inquiries on potential synergy between the benefits of renewable biofuels from agriculture and the advantages of electric vehicles needs significant scholarly attention.

Another intriguing research option suggested by the absence of correlations in our bibliometric data is the topic of bioethanol as a predominant technological fuel additive. is a lot of literature on the technological and economic limits on the amount of ethanol that can be used as an oxygenate in US car fuels. However, there is still not enough literature on this topic.

Lastly, Figure 16 demonstrates how the representativeness of each cluster has changed over time. At the start of the research on this topic, the most important group was the one that looked at how biofuels affect the environment (cluster (iii)). changed since then. The figure shows that the most recent studies that look at how biofuels affect commodity prices and overall price dynamics (cluster (i)) have been the most interesting. The second most interesting studies look at how public policies affect the use of ethanol and the ability to change

fuel blending (cluster (ii)). In this way, the subjects related to clusters (i) and (ii) will provide the most promising avenues for future research.

**Energies 16 00428 g016:**

**Final Thoughts:**

This article suggests an examination of the current literature about the impact of ethanol on fluctuations in retail gasoline prices in the United States. To do this, we performed a comprehensive literature review adhering to established principles. We took a sample of 109 articles and used bibliometric quantitative methods together with qualitative content analysis to look at them. The originality of this paper is clear, as no comprehensive literature evaluation aimed at assessing the influence of ethanol on gasoline retail prices has been found.

Initially, bibliometric techniques were employed to characterize the sample, facilitating the discovery of trends within the examined topic. We also made and studied thematic, conceptual, and co-occurrence maps. These maps show subjects including energy policy, costs, price dynamics, commerce, and the energy market. Recently, the most important phrases have been "retail fuel spreads," "fuel markets," "E85," "energy prices," and "meta-analysis."

Second, based on the chosen sample and grouping methods, the main cluster structures were found and looked at briefly. This led to three lines of research: (i) how biofuels affect commodity prices and overall price changes; (ii) how public policies affect the use of ethanol and the ability to change how fuel is blended; and (iii) how biofuels affect the environment. There are no definitions for these clusters ahead of time, either in the literature or through software; thus, the articles in the sample need to be looked at in detail.

Third, the general and partial equilibrium model was the most commonly utilized in the sample to show how changes in ethanol requirements affect gasoline prices. There is no agreement on how ethanol affects the price of gasoline in US stores, although the most common outcome is that adding alcohol lowers the price of fuel at the pump.

In the fourth moment, we demonstrate that the current focus on the effects of biofuels on commodity pricing and overall price dynamics is the most pertinent and trending area of research, as indicated by our analysis of the published sample.

The current study's shortcomings stemmed from methodological decisions, including: (1) reliance on a single database for article extraction and (2) the formulation of search strings that may have omitted pertinent works. The following tactics helped reduce these limitations: (1) choosing the biggest database of academic works in the world (Web of Science), and (2) utilizing a lot of tries to make the search strings fit the works that were most relevant to the issue being examined. Another constraint is the inclusion and exclusion criteria of each article in the final sample, which we aimed to address through the involvement of four distinct researchers.

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