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ALSO IN THIS ISSUE

Revoking China's Preferred Trade Status Would Be Costly for California Agriculture

Colin A. Carter and Sandro Steinbach

The U.S. House Select Committee on the Chinese Communist Party recently issued a report on China's economic policies. The committee suggested countering economic and security threats with U.S. trade policy changes aimed at China. A key recommendation was discontinuing the Permanent Normal Trade Relations (PNTR) status, which currently allows China to trade with the United States at most-favored-nation tariff rates. Revoking PNTR would likely provoke trade retaliation by China, potentially raising China's agricultural import tariffs by 9.5%, equivalent to the change in U.S. tariffs if China's PNTR status was revoked. This could result in the value of California's agricultural exports to China falling by one-third, with associated trade losses of $1 billion annually.

There is a growing consensus among U.S. lawmakers on the need to reassess the U.S.-China trade relationship and possibly ramp up protectionism. This view is partly driven by concerns over some of China's political actions perceived as threats to U.S. national security and human rights violations in China. In addition, of concern to the United States is that China has not evolved into a market economy, which contradicts many rules and objectives of the World Trade Organization (WTO). Calls to revoke China's Permanent Normal Trade Relations (PNTR) status would significantly raise U.S. import tariffs on products from China. As a result, China would be incentivized to respond by raising its import tariffs, leading to another trade war. This would be bad news for California agriculture because it would lead to lower farm prices, lost export opportunities, and lost jobs, as experienced during the trade wars in 2018/19 during the Trump administration. China is the world's largest importer of U.S. agricultural products, and U.S. farmer access to that large market is again at risk.

The economic relationship between the United States and China has evolved considerably since President Nixon's visit in 1972, leading to formal trade relations and China's eventual accession to the WTO in 2001. This journey, marked by President Clinton's enactment of H.R. 4444, granted China the most-favored-nation status, aligning its tariff rates with other WTO members. The legislation resulted in profound changes in global trade dynamics, reducing China's average import tariffs and resulting in a substantial increase in bilateral trade between the United States and China. U.S. exports to China, particularly agriculture, machinery, and technology, have surged over the past two decades.

The U.S. criticism of China's WTO membership centers around non-compliance with WTO regulations and accession commitments. However, we note that the United States won all of its WTO disputes against China in the last twenty years, resulting in economic policy adjustments by China, demonstrating the WTO's effectiveness in enforcing compliance. Unfortunately, the WTO Appellate Body became defunct in 2019, mainly due to the United States blocking appointments of new appellate body judges. Since then, the ability to enforce trade rules with China has been severely undermined because the appeals mechanism is not functioning. Instead of going through the WTO to address trade concerns, the Trump Administration imposed import tariffs on

Chinese imports in response to intellectual property violations. This led to a cycle of retaliatory tariffs, with considerable negative implications for California agriculture. These retaliatory tariffs affected over $32 billion worth of U.S. agricultural exports at the time of implementation without resulting in China altering its economic practices. The shift from multilateral WTO dispute resolution to unilateral tariff wars reflects a change in U.S.-China trade relations, raising questions about the future of international trade norms and enforcement. The United States turned its back on the WTO, which is unfortunate because other countries may follow suit and increase protectionism.

Following the 2018/19 trade war, U.S. lawmakers have implemented additional economic restrictions against China. For instance, the passing of the 2021 U.S. Uyghur Forced Labor Protection Act aimed to curtail U.S. imports of goods produced with forced labor in China. The 2022 U.S. export controls on advanced artificial intelligence (AI) semiconductor chips have meaningfully impacted China's technological capabilities and the modernization of China's military. Amid these tensions, proposals to revoke China's PNTR status have gained momentum in Washington, D.C., reflecting a shift in U.S.-China economic relations before the presidential elections. This policy shift signals a critical reassessment of the U.S.-China economic engagement, with potentially significant implications for California farmers and ranchers.

California Agriculture Depends on Access to China's Market

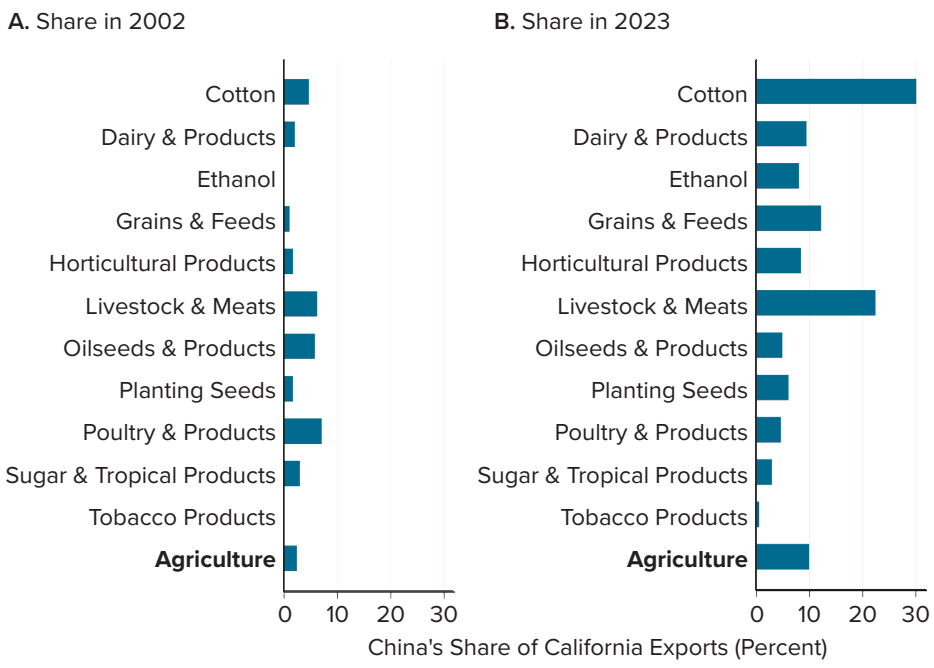
Since China joined the WTO in December 2001, California's annual agricultural exports to China expanded from $0.2 billion to more than $2.6 billion in 2023. During the same period, the share of California agricultural exports to China grew from 2.4% to 9.9% of total California agricultural exports. The new market access contributed to shifts in California's agricultural production, with the area of cash crops expanding considerably. For example, the almond-bearing acreage increased from 0.6 million in 2002 to 1.4 million in 2023. This period also saw sharp price increases for various export commodities, illustrated by the price of almonds, which increased from $1.11 per pound in 2002 to $4.00 per pound in 2014.

However, when the 2018/19 U.S.-China trade war broke out, trade retaliation resulted in declining export prices for various California cash crops. For instance, the price of almonds plummeted to $1.40 per pound. Farmers in the midwestern United States were overcompensated with federal government subsidies to offset economic losses during the 2018/19 trade war, while California farmers were undercompensated.

Figure 1 shows that California's dependency on China as a market for agricultural products varies by product group. The figure plots China's share of California agricultural exports in 2002 versus 2023. As mentioned, the export dependency ratio has quadrupled from 2.4% to 9.9% since China's WTO accession. For certain product groups, the increase is significantly larger. For instance, about 8.4% of horticultural exports now go to China, a fivefold increase since 2002. The highest export dependencies are cotton (30.1%), livestock and meats (22.4%), and grains and feeds (12.2%).

While the 2018/19 trade war harmed California agriculture, certain sectors stand out as having experienced the brunt of the trade losses. Tree nut producers were among the most severely impacted. Previous economic studies found that California almond export losses in marketing years 2017/18 to 2021/22 exceeded $755 million, leading to a considerable increase in U.S. almond inventories. This pattern from the previous trade war implies that the potential trade effects of PNTR removal are likely to be significant.

Figure 1. China's Share of California Agricultural Exports in 2002 versus 2023



Source: Authors' own calculations based on data from the U.S. Census Bureau (2024).

PNTR Removal Could Cost California Agriculture Dearly

Alternative proposals to revoking China's PNTR status are being considered in Washington, D.C. Table 1 shows the average U.S. import tariff schedule with and without PNTR status. The leading proposal would elevate tariffs on all Chinese imports from the most-favored-nation rates (also known as column 1 rates) to higher column 2 rates of the U.S. Harmonized Tariff Schedule. The column 2 rates are exclusive to countries such as Cuba, North Korea, Russia, and Belarus. Cuba and North Korea face complete economic embargoes, while Russia and Belarus had their PNTR status withdrawn following the Russian invasion of Ukraine.

Implementing the PNTR revocation would raise the average import tariff on Chinese agricultural products by 9.5%—from 5.1% under column 1 to 14.6% under column 2. The impact on import tariffs for other non-agricultural sectors would be larger, with the average import tariff over all sectors going up from 3.9% to 32.5%. Horticultural products, dairy, livestock, and meats would experience steep increases in import tariffs. In addition to the proposal to remove PNTR status, and thus elevate U.S. import tariffs on all Chinese imports to the column 2 rates, another proposal was introduced during a recent debate by the Select Committee to establish a unique tariff regime for Chinese imports, necessitating regular Congressional approval. This outcome could be even worse for California agriculture.

To estimate the potential trade effects of removing China's PNTR status, we assume a reciprocal and uniform `tit-for-tat' trade response from China, which means that China would raise its import tariffs on inbound agricultural products by 9.5%. This assumption draws on the trade policy dynamics observed during the 2018/19 U.S.-China trade war, where China responded with equivalent tariff hikes on U.S. agricultural imports. Those retaliatory measures increased China's agricultural import tariffs by 19.1% in 2018/19. One previous Virginia Tech study estimated that these tariffs caused a 71% reduction in U.S. agricultural exports to China compared to their 2016/17 levels.

Table 1. Potential Import Tariff Increases After PNTR Revocation

Product Groups	Column 1 Tariff Rate (%)	Column 2 Tariff Rate (%)
Cotton	0.8	0.8
Dairy & Products	6.9	17.3
Ethanol	1.9	20.0
Grains & Feeds	3.3	12.3
Horticultural Products	3.6	15.5
Livestock & Meats	2.1	11.4
Oilseeds & Products	8.8	17.9
Planting Seeds	0.1	0.4
Poultry & Products	0.7	3.0
Sugar & Tropical Products	3.5	11.8
Tobacco & Products	42.5	45.3
Agriculture	**5.1**	**14.6**
All Sectors	3.9	32.5

Source: Authors' own calculations based on 2023 tariff data from the U.S. International Trade Commission (2024).
Note: Column 1 rates reflect the most-favored-nation rates, while the higher column 2 rates reflect the U.S. Harmonized Tariff Schedule exclusive to countries such as Cuba, North Korea, Russia, and Belarus.

Table 2. Potential Impact of PNTR Revocation on California Agricultural Exports to China Based on 2023 Trade Flows

Product Groups	Trade Effects (Percent)		Export Value Effects (Millions of Dollars)	
	Lower Bound	Upper Bound	Lower Bound	Upper Bound
Cotton	-0.3	-0.4	-0.47	-0.57
Dairy & Products	-29.7	-36.4	-67.17	-82.23
Ethanol	-54.9	-67.2	-0.10	-0.12
Grains & Feeds	-28.4	-34.8	-82.99	-101.59
Horticultural Products	-37.3	-45.7	-527.59	-645.84
Livestock & Meats	-32.6	-39.9	-136.84	-167.52
Oilseeds & Products	-26.9	-32.9	-12.13	-14.85
Planting Seeds	-1.7	-2.1	-0.45	-0.55
Poultry & Products	-7.9	-9.7	-0.80	-0.98
Sugar & Tropical Products	-19.8	-24.2	-4.19	-5.13
Tobacco & Products	-16.4	-20.0	-0.01	-0.01
Agriculture	**-28.4**	**-34.8**	**-832.74**	**-1,019.39**

Source: Authors' own calculations based on column 1 and column 2 tariff data from the U.S. International Trade Commission (2024), 2023 California export data from the U.S. Census Bureau (2024), and retaliatory tariff data from the PRC Ministry of Finance (2024).

Another study by the USDA estimated a decline in U.S. agricultural exports to China from $18.5 billion in crop year 2017/18 to $7.8 billion in crop year 2018/19, marking a 58% decrease in export value. These figures provide a basis for our estimates in Table 2 (on page 3) of the potential consequences of China's response to the revocation of its PNTR status.

Table 2 shows the predicted trade effects (in value terms) of possible retaliation from China in response to PNTR removal. We assume China's new import tariffs would be equivalent to the higher U.S. tariffs they would face in the U.S. market, going up from column 1 to column 2 in Table 1. In Table 2, we show lower and upper bound estimates of trade losses based on the trade war tariff elasticities in the literature, which are -3.04 and -3.72, respectively. These elasticities measure how much trade values respond to a 1% increase in the ad valorem tariff rate. On average, California's agricultural export value to China would decline by 28.4% to 34.8% compared to a scenario without PNTR revocation. Based on 2023 California agricultural exports, this would result in trade losses between $0.8 billion and almost $1 billion, equal to about 4% of the value of the 2023 California agricultural shipments to all export destinations.

This impact may sound small, but in international agricultural markets, a relatively small change in trade volume can have significant price impacts. Interestingly, there are considerable differences between product groups, with horticultural products, livestock and meats, dairy, and grains and feeds facing the brunt of the potential trade damage. Over 60% of the trade losses would be concentrated on horticultural products. Producer groups that rely heavily on China, such as tree nuts, would see major impacts that could further exacerbate existing market challenges caused by the lingering 2018/19 U.S.-China trade war, supply chain disruptions, and sluggish domestic demand.

Our estimates of trade losses are a lower bound of the potential economic impact caused by a `tit-for-tat retaliation' scenario. For instance, U.S. almonds still face a 15% retaliatory tariff on top of the 10% most-favored-nation rate in the Chinese market. Pistachio exports from the United States to China face a 5% most-favored-nation tariff plus a 20% retaliatory tariff. These retaliatory tariffs are left over from the 2018/19 trade war and are called Section 232 retaliatory tariffs.

We believe our estimates are reasonable but may have a lower bound because we don't know how China would react to losing PNTR status. For instance, China might revoke the waiver for U.S. agricultural products granted in March 2020. These waivers nullified Section 301 retaliatory tariffs implemented in 2019 on top of Section 232 retaliatory tariffs. In the case of tree nuts, losing the Section 301 waiver would mean tariffs would increase by an additional 30%.

Conclusion

Since China joined the WTO over two decades ago, U.S. agricultural exports to China have surged. This market access was handed a significant setback in 2018/19, when the United States started a trade war that resulted in major trade retaliation by China. That trade war was a disaster from the U.S. perspective and resulted in lower farm prices, lost export opportunities, and job losses for California agriculture that continue to impact the industry.

The potential revocation of China's PNTR status and the associated implications of tariff escalations would further disrupt this trade relationship, risking substantial economic losses for California agriculture due to reduced agricultural exports. This scenario underscores the need for informed trade policies that consider the complexities of international market dynamics and the essential role of trade relations in sustaining the vitality of California's agricultural economy. Once access to a market is lost, gaining it back is difficult, as the 2018/19 trade war has shown.

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Oxford Economics. 2023. "The Impact of China PNTR Repeal and Increased Tariffs on the U.S. Economy and American Jobs." A Report Prepared for the U.S.-China Business Council. Available at: https://bit.ly/3xtkk6k.

Carter, Colin A., Jiayi Dong, and Sandro Steinbach. 2020. "2018 Trade War, Mitigation Payments, and California Agriculture." *ARE Update* 24(2): 1–4. University of California Giannini Foundation of Agricultural Economics. Available at: https://bit.ly/43SYGo0.

Does Seeing a Wind Turbine Depress Your Home Value?

Wei Guo, Leonie Wenz, and Maximilian Auffhammer

Renewable energy, especially from wind power, is vital for a sustainable future. However, its adoption encounters challenges, primarily local resistance. We explore the frequently neglected aspect of wind turbine visibility affecting property values across the United States. Our study reveals that wind turbines close to homes can reduce their value by up to 8%. The good news is that this impact diminishes significantly with greater distance for recently installed turbines and tends to fade over time.

Over the last three decades, the average home with a wind turbine in its viewshed sold for 1.2% less than an identical home that did not.

Photo Credit: Karsten Wurth on Unsplash.

Renewable energy sources are essential for transitioning towards a decarbonized energy system and making the electrical grid more environmentally sustainable. Clean energy alternatives like wind power can effectively replace fossil fuels, contributing to reduced air pollution and slowing down climate change.

Wind power has emerged as one of the fastest-growing sources of renewable energy worldwide. However, the implementation of wind energy infrastructure, including wind turbine, faces significant challenges. One major obstacle is the opposition from local communities.

A number of arguments have been put forward against wind turbines. According to critics, they are noisy, cause a visual flicker for some homes during certain times of the day, and kill birds. Others contend that they are ugly objects that destroy our enjoyment of the landscape. These concerns can lead to conflicts between renewable energy development and environmental preservation.

In a study released last month, we examined how the sight of a wind turbine from your property affects the value of your home. This is crucial for evaluating the trade-offs between the benefits and costs of renewable energy sources, and for gaining a thorough understanding of their impacts. The findings can also be used to estimate how much homeowners should or could be compensated when a wind turbine is constructed in their field of view.

The research focuses on the usually overlooked impact of wind power generation on local communities. Specifically, the study addresses how wind turbines affect the actual value of homes. The main aim is to contribute to the benefit and cost analysis of renewable energy development, facilitating more informed decision-making for both policymakers and the public regarding new projects.

In pursuit of this objective, we have constructed a database on wind turbine visibility—incorporating details on the location and height of each utility-scale turbine that has contributed power to the U.S. grid—for each home sold since 1997. The database relies on a high-resolution elevation map, which accounts for the underlying topography of the landscape. We used statistical methods to discern the impact of wind turbine visibility on home values.

The intuition is simple. Assume that Rich and Ellen live next door to each other in otherwise identical homes. The only difference is that out her living room window, Ellen can see a 500 foot tall wind turbine and Rich cannot because a hill is in the way. Both sell their home at an identical time. The difference in sales price reflects the effect of seeing the wind turbine—as the homes are otherwise identical. We conducted this exercise for all homes within 10 kilometers (km) of a wind turbine that were sold between 1997 and 2020, before the COVID pandemic threw housing markets into a tailspin.

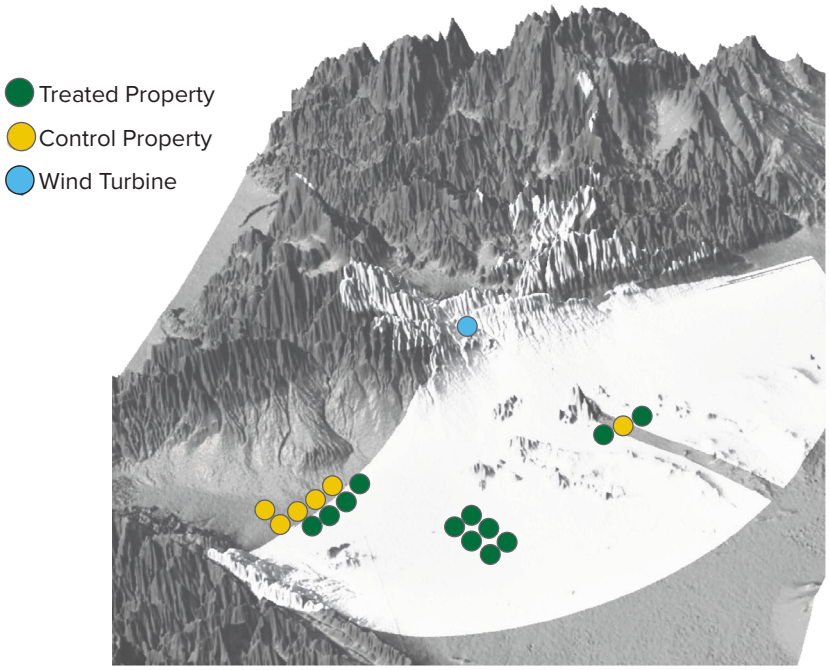
Figure 1 (on page 6) shows what we did for each wind turbine. The blue circle is a wind turbine. The green circles are homes that can see the wind turbine. The yellow circles are homes that cannot. We compared sales prices for green and yellow circles and took the difference—accounting for differences in home characteristics, time of sale, and location, to get as close as we can to the example case described for Rich and Ellen.

Findings

Our research revealed four main findings, which are highly policy relevant.

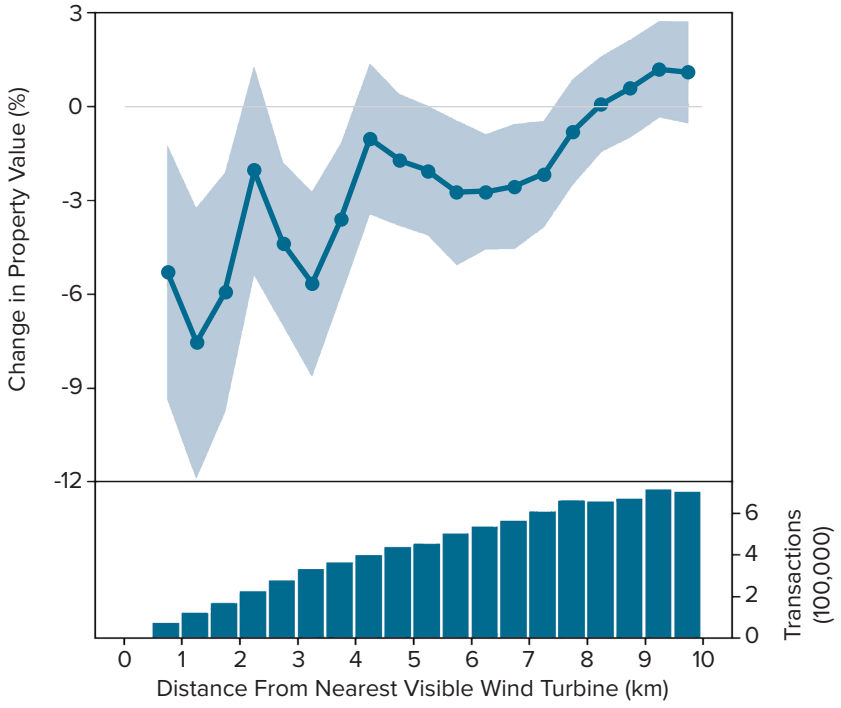
First, from 1997–2020, the average home in our sample with a wind turbine in its viewshed (the geographical

Figure 1. Surface and Viewshed of a Patterson Pass Wind Turbine in Altamont, California



Source: Authors' calculations based on United States Wind Turbine Database (USGS) and the Shuttle Radar Topographic Mission (NASA).
Note: The figure depicts the landscape topology and viewshed of a wind turbine located in the Patterson Pass Wind facility in Altamont, California. It has a hub height of 24 meters, and rotor diameter of 16 meters. Light-colored areas indicate locations from which the turbine is visible, while dark-colored areas indicate areas where the turbine is not visible. Accordingly, green circles are properties in the treatment group (those where the turbine is visible) whereas yellow circles are housing properties in the control group (those where the turbine is not visible).

Figure 2. Effect of Wind Turbine Visibility on Property Value by Distance



Source: Authors' calculations based on regression analysis.
Note: The figure plots the effect of wind turbine visibility on property values for different distance bins. Each distance bin represents a 500-meter range, determined by the distance from the nearest visible wind turbine.

area visible from a given location) sold for 1.2% less than an identical home that did not. This is not an insignificant number. For homes valued at $500,000, this would be roughly a $6,000 drop in value.

If we estimate what this means for all homes in the United States that are located within 10 km of a wind turbine where the turbine is in its viewshed, this comes to a destruction of $25 billion in home values over the three decades we analyzed. However, compared to the value of residential real estate in the United States—which by some estimates is roughly $45 trillion—it is not a big share of the overall value, simply due to the fact that most homes do not have a wind turbine in their viewshed.

Second, homes closer to wind turbines experienced larger declines in home values. Figure 2 shows that the visual disamenity of having a turbine in your viewshed reduces property values by up to 8% within a neighborhood range of 1.5 km (0.9 miles). However, the number of properties within this distance is small. Nationally, during our period of analysis, there were fewer than 250,000 transactions within 1.5 km of the nearest wind turbine, as opposed to approximately 8.5 million transactions within 10 km.

As we move further away from a turbine, the effect becomes smaller; it is statistically indistinguishable from zero at 8 km (5 miles) from the nearest wind turbine. To put this in perspective, if one stretched out an average-sized arm and held up an aspirin tablet, this would equate to the perceived size of an average wind turbine five miles away. Were the same wind turbine one mile away, it would appear to be roughly the size of a golf ball. So the further away a home is from a turbine, the smaller the effect on the home value.

Third, we further investigated what drives the visual disamenity effect. We found that the negative impact of wind turbines on property values is primarily observed among urban properties, with negative (but not very precisely estimated) effects in rural areas. Our analysis based on geographical altitude suggests that the negative impact of wind turbine visibility is particularly pronounced in non-mountainous regions. We also observed a strong correlation between local political leanings and disamenity effects, with right-leaning communities experiencing a significantly greater impact compared to left-leaning areas. Last, the visual disamenity is more accentuated in high-income versus low-income areas. So rich, conservative, urban, flat areas "dislike" wind turbines the most.

Finally, and most importantly, we found that the negative impact of seeing a wind turbine disappears over time. There is a much bigger effect on nearby housing values right after a wind turbine is constructed compared to a few years later. But most importantly, if we look at whether the estimated effect changes over time, we find, no matter how we slice it, that wind turbines installed in the past decade had a much smaller effect. This effect is so much smaller, in fact, that it is indistinguishable from zero in recent years.

What this implies is that we are probably getting used to seeing wind turbines. This might be similar to the early experience of folks having transmission infrastructure nearby their homes when transmission towers were new. Initially, there was big resistance, but most of us got used to seeing them as a regular part of the landscape.

Conclusions

But, you ask, so what? Decarbonizing the electrical grid is the single most important thing we can do to have a chance at keeping global warming below the 2 degrees Celsius rise in temperature—an important international climate policy goal and an integral part of the Paris climate agreement. Wind, solar, and possibly nuclear energy are going to play a key role in this effort. In order to ramp up wind generation, we will have to install significantly more and bigger wind turbines—some of which will be near homes on and offshore.

Economists on both sides of the aisle agree that before deciding to enact a policy, we should compare its benefits to the costs. The benefits from wind generation are somewhat straightforward to calculate, as we have decent numbers on the benefits of avoided damages from emitting less carbon (e.g., the social cost of carbon).

On the cost side, things get trickier. There are complicated calculations involved in figuring out the costs of connecting new installations to the grid and possibly building significant amounts of new transmission capacity. Our research helps quantify another important cost component: how much people dislike seeing these structures where they live.

How do we use these numbers? We can use the numbers in our paper in a traditional benefit-cost analysis to compare different locations of wind turbine installations to minimize social costs. But maybe even more concretely, you could use these estimates to figure out how much one should compensate homeowners in areas where wind turbines are being proposed and possibly built. This is true in residential areas as well as America's Heartland, where the wind blows and the corn grows!

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Jarvis, Stephen. 2021. "The Economic Costs of NIMBYism: Evidence From Renewable Energy Projects." Energy Institute WP 311. Available at: https://haas.berkeley.edu/wp-content/uploads/WP311.pdf.

Faculty Profile: Alexandra Hill

Alexandra Hill
Assistant Professor of Cooperative Extension
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Alexandra (Ali) Hill joined the Department of Agricultural and Resource Economics at the University of California, Berkeley as an assistant professor of Cooperative Extension in July 2023. Prior to this role she worked as an assistant professor of Agricultural Economics at Colorado State University. She earned her Ph.D. in agricultural and resource economics from UC Davis in 2019, and she holds master's and bachelor's degrees in agricultural and consumer economics from the University of Illinois Champaign-Urbana.

Her research centers around the U.S. agricultural workforce and seeks to demonstrate how a variety of factors impact worker well-being, quantified in terms of income or health, and how these factors then impact businesses, in terms of key performance indicators like productivity, output quality, profits, and workplace injuries. Hired farmworkers contribute greatly to the racial, ethnic, cultural, and socioeconomic diversity of U.S. agriculture; however, they are frequently not treated equitably, and face a multitude of economic, physical, legal, and emotional hardships in their personal and professional lives. Hill's research seeks to dismantle these inequities by finding avenues through which employers and policymakers can enhance worker well-being and cultivate a more prosperous agricultural industry.

The availability of appropriately skilled workers when and where they are needed is critical for the viability of agricultural businesses. Hill's work on agricultural labor supply centers around understanding and documenting the factors that influence potential employees' willingness to work for agricultural businesses and how this has changed over time.

One of her current projects studies the reduction of follow-the-crop migration among U.S. agricultural workers. The project defines local and migrant labor market areas geographically and shows how reduced mobility among farmworkers mediates how agricultural operations can respond to environmental stressors and government policies.

Hill's work related to employee productivity seeks to identify payment schemes and other workplace policies that can increase both business profitability and worker incomes. In recent work, she showed that increases in the piece-rate wage paid to harvesters can cause them to work more quickly, delivering higher quantities, but also potentially leading to lower quality—measured as the percentage of output without any defects. She is also exploring whether employers can increase worker incomes, output, and quality by offering bonuses tied to both output and quality, rather than a traditional quantity-based, piece-rate payment.

Efforts to ensure the continued health and well-being of the agricultural workforce are beneficial for workers and are also essential for the sustainability of the industry. Using improved surveillance and monitoring, Hill is working to improve our understanding of the hazards associated with agricultural work.

In recent work, she documented the undercounts of nonfatal injuries and illnesses among U.S. agricultural workers in national data sources. She is now working with collaborators at UC Davis and the Western Center for Agricultural Health and Safety to produce more accurate and detailed estimates of agricultural injuries and illnesses in California so that policymakers and industry stakeholders can make more informed decisions to improve workplace health and safety.

Hill is also interested in understanding how policies impact and shape the agricultural sector. She is currently working to document how California's recent overtime regulation for agricultural workers impacted the state's crop workforce in terms of working hours and pay as detailed in her recent *ARE Update* article "California's Overtime Law for Agricultural Workers: What Happened to Work Hours and Pay?" She is also conducting research on the potential implications of immigration reform policies—including the farm workforce modernization act—for agricultural employees, employers, and the industry.

When Ali is not researching or travelling, you will find her jogging (slowly) in the Berkeley hills, rock climbing, or training Muay Thai.

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Conflicts in California's Food Safety and Sustainable Agricultural Practices

Emily Zakowski, Rachael Goodhue, and Kevi Mace

On-farm food safety practices focus on mitigating sources of foodborne pathogens, such as *Escherichia coli* (*E. coli*) and *Salmonella enterica*, and managing potential routes of exposure through water, soil, and animal movement. However, many practices conflict with practices designed to enhance sustainability or environmental quality. Consequently, California growers must balance policy and program requirements for food safety and environmental protection to produce a safe, healthy, and sustainable food supply.

Sustainable farming practices like on-farm ponds may attract wildlife that will lead to lost points on food safety audits.

Photo Credit: Ginger Jordan on Unspalsh.

Foodborne illness outbreaks have serious consequences for agriculture by disrupting supply chains, shaking consumer confidence, and causing economic losses, and potentially resulting in illnesses and deaths. Recent outbreaks and liability concerns have increased pressure on growers to address food safety risks. In 2019, the U.S. Food and Drug Administration (FDA) initiated the "new era of smarter food safety," and industry groups are strengthening their food-safety practice standards, including water treatment, animal exclusion, and no-harvest buffer zones.

Meanwhile, California has invested significantly in encouraging the adoption of sustainable, climate-smart agricultural practices through governmental policies and programs. Statewide initiatives include efforts to promote water quality and use-efficiency, soil health, wildlife conservation, and pest management with lower chemical inputs. Among these system-wide efforts to promote sustainability are practices that conflict with on-farm government- or industry-set requirements for food safety.

In this regulatory context, growers may be constrained by competing pressures in their attempt to balance and promote both objectives. For example, sustainable practices that support wildlife or integrate livestock on-farm are counterbalanced by costs such as lost production from no-harvest buffer zones. The challenge of balancing the two can limit the adoption of alternative, sustainable practices and the success of policies and programs that support them.

Key On-Farm Food Safety Requirements

Requirements vary in form, governance, and prescriptiveness. Under the federal Food Safety Modernization Act (FSMA), the FDA sets risk-based, prevention-oriented safety standards. FSMA's Produce Safety Rule (PSR) outlines guidelines for managing major sources of potential contamination. The California Department of Food and Agriculture's (CDFA) Produce Safety Program is the designated authority for inspection and enforcement of the PSR.

Voluntary commodity-specific programs, such as those under the California Leafy Greens Marketing Agreement (LGMA) and the California Cantaloupe Advisory Board, set food safety guidelines that are typically more rigorous than FSMA. Audits by USDA-certified government inspectors ensure compliance and are conducted separately from FSMA inspections.

Large processors, retailers, and buyers may impose additional, more-stringent requirements. These requirements are often proprietary information, making it difficult to assess their incremental impact on either food safety or grower returns. Inspections to meet buyer standards are separate from FSMA compliance inspections.

Key Sustainable Agriculture Initiatives for California Growers

Within CDFA, the Environmental Farming Incentive Program funds soil health, water efficiency, and nutrient management practices on agricultural lands, including the Healthy Soils (HSP) and State Water Efficiency and Enhancement (SWEEP) Programs. These programs, along with the federal Environmental Quality Incentives (EQIP) and Conservation Stewardship (CSP) Programs, promote practices such as cover crops, hedgerows, compost, buffer strips, grassed waterways, and constructed wetlands. These programs are voluntary. However, environmental regulations can require growers to implement sustainable practices, such as establishing vegetated setbacks as part of riparian area management.

Conflicts: Water

Maintaining water quality is important to human and environmental health. Vegetative buffers, grassed waterways, and constructed wetlands act as natural filters for microbes, nitrogen and other fertilizers, and pesticides. In order to manage nitrogen runoff, Regional Water Quality Control Boards (RWQCB) are starting to require growers to monitor and report, as well as limit, the amount of nitrogen that is applied and removed from fields. Water conservation and efficiency practices, such as groundwater recharge, are increasingly prevalent amid frequent drought conditions statewide. Starting in 2020, the Sustainable Groundwater Management Act (SGMA) began requiring local agencies to form groundwater sustainability agencies tasked with developing and implementing groundwater sustainability plans.

Food safety requirements regarding water focus on minimizing the risk of contact with pathogen-contaminated water. The PSR sets agricultural water quality standards. Antimicrobial and chlorine treatments may be required to meet these water quality standards. Buyer food-safety requirements can mandate specific no-harvest buffers between harvestable crops and pooled water, as well as require specific practices when using exposed water sources such as irrigation ditches and ponds.

Such food safety requirements may restrict or eliminate the use of on-farm practices that protect water quality and quantity. Chemically treated exposed water may expose wildlife to toxins, and in turn, wildlife may contaminate the water and irrigated crops with pathogens. Growers can lose points on compliance audits if they irrigate with surface water rather than groundwater, despite depleted groundwater reservoirs in some regions. The PSR requires measures to reduce potential "hazards as a result of contact of covered produce with pooled water." Industry standards are stricter: the LGMA requires a no-harvest buffer of at least 30 feet from flood water, while buyers and shippers may require 30–50 feet from irrigation reservoirs, ponds, and catch basins. These requirements may conflict with groundwater recharge and flood-management efforts.

Growers have adjusted their production practices in response. Growers have reported creating no-harvest buffers and even disking under entire fields of crops when a perceived risk (e.g., animal feces) is present. However, disking leaves excess nitrogen in the field, which conflicts with enforceable water quality regulations that require applied and removed nitrogen reporting. One almond grower reported that the guidance provided to them by food safety auditors would have resulted in a violation of the Clean Water Act.

Reusing water, saving water, or using water for habitat improvements can conflict with food safety. Pooled and flood water, waterbodies (ponds, reservoirs, wetlands), and irrigation reuse systems (tailwater recovery ponds), may attract animals and can lead to lost points on food safety audits. Biological material from utilizing dairy effluent for irrigation presents a food-safety concern for crops harvested from the ground. Land fallowed under SGMA and other water-use restrictions may be managed with non-crop vegetation to support groundwater recharge. Yet, non-crop vegetation is one of the most-cited food safety concerns due to the increased risk of contamination.

Conflicts: Soil

The government heavily incentivizes practices that support soil health financially; from 2016 to 2023, the CDFA allocated $105 million in state funding to the HSP and funded 1,500 projects. Programs such as HSP, EQIP, CSP, and many others promote practices including composting, crop rotation, and cover crops, which can enhance soil microbial abundance, activity, and diversity.

Food-safety requirements raise concern over the use of soil amendments containing animal materials that may introduce *E. Coli* or other pathogens. Non-crop vegetation, including cover crops, can create issues for food safety when they attract wildlife that may harbor pathogens. While the PSR sets application and microbial treatment standards for the use of biological soil amendments of animal origin, they tend to be broadly described, which can leave growers subject to varying interpretations for enforcement.

Commodity-specific and buyer requirements may also apply. The LGMA does not allow soil amendments that contain raw manure, untreated animal products, or un-composted green waste; if they have been applied, there is a required one-year waiting period prior to producing leafy greens. The National Organic Program also requires a waiting period. Buyers may require longer waiting periods. As a result of food safety requirements, growers in orchard systems are moving toward composted manure; however, current requirements can make on-farm composting difficult. For example, shelling factories would not accept one grower's almonds if compost had been applied to the ground.

Conflicts: Domestic and Wild Animals

Diversified, mixed crop-livestock farming systems are often considered a sustainable practice; grazing can enhance soil fertility. Many programs promote on-farm wildlife habitat through practices that support non-crop vegetation, such as hedgerows.

Hedgerows provide habitat for pest's natural enemies, pollinators, and other wildlife.

The presence of animal activity, wild or domestic, can cause food-safety concerns. Cats, which support natural rodent control, introduce the possibility of carrying toxoplasmosis into packing houses. Furthermore, growers will use animals to graze cover crops prior to harvest, but droppings can create food-safety issues. Livestock are known to harbor pathogens in feces; thus, the integration of livestock into farm operations is sometimes prohibited due to the risk of contamination. Small and medium farms have shown increased interest in diversifying operations by integrating livestock, such as poultry, sheep, and pigs, that can help support soil health but are sometimes discouraged by food-safety inspectors.

While the science regarding the role of wildlife is not as well-established, there are concerns within the agrifood industry about the risks. Wildlife such as deer are sometimes attracted to cover crops in ground-harvested nut orchards, which conflicts with some buyer food-safety requirements to restrict wildlife. While FSMA does not require farms "to exclude animals…destroy animal habitat…or otherwise clear farm borders," growers may employ these practices, especially under pressure from stricter requirements. The PSR does require growers to check for potential contamination from animals and "take all measures reasonably necessary" to determine whether the crop can be harvested.

Hedgerows, a highly incentivized field structure, can result in lost points on food-safety audits. Buyers' no-harvest buffer requirements can range from five feet to an entire field. To minimize the risk of animal intrusion, growers report discouraging, and even directly eliminating, wildlife and habitat. A farm that manages on-farm habitat and is adjacent to wildlife refuges reported that wildlife observed by auditors at harvest resulted in crop destruction.

Policy Implications

The difficulties growers face undertaking sustainable agricultural practices while meeting food-safety requirements may inhibit the success of governmental policies meant to support those practices. Consequently, growers may have trouble achieving regulatory compliance in the face of policies with competing objectives.

Food safety conflicts can be costly for growers. No-harvest buffers can reduce revenues by reducing productive land. Growers forced to alter practices may experience yield loss or increased production costs. These conflicts can also prevent information sharing between growers—a key strategy for sustainable practice adoption. In the face of regulatory uncertainty with regard to competing objectives and conflicting practice requirements, growers may be hesitant to discuss their farm management practices for fear of regulatory enforcement; this hesitancy prevents the spread of best practices through farmer-to-farmer knowledge networks.

Given these challenges, policymakers can evaluate interactions among policies and programs to help growers balance food safety and sustainability. This may include considering the following actions: evaluating the practices eligible for incentive funding; developing metrics for policy/program and practice adoption success; funding additional research about how to achieve food-safety objectives while also using sustainable practices; and endeavoring to ensure that mandatory environmental regulations do not compromise food safety.

The conflicts growers face in on-farm management practices reflect competing priorities of industry stakeholders and government agencies. These parties should engage directly; growers alone cannot be responsible for determining what constitutes safe and sustainable food for society.

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This research was conducted while Zakowski was employed at the CDFA.

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Spalding, Ashley, Rachael E. Goodhue, Kristin Kiesel, and Richard J. Sexton. 2023. "Economic Damages of Food-Safety Incidents in Complex Markets: 2018 *E. coli* Outbreak and Romaine Lettuce." *California Agriculture*. 77(1): 22–29 January–March. Available at: https://bit.ly/3U8BX36.

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