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Fighting For An End To Federal Ethanol Mandates May Be An Ideal Social Justice Cause For Students At U.S. Catholic Universities

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Introduction

In the end, neither Democrat Bernie Sanders nor Republican Ted Cruz won their party's 2016 presidential nomination, but it can be argued that both had a profound impact on the future direction of one of America's most damaging public policies: government mandated ethanol fuel production. Bernie Sanders rallied America's young people to issues related to fairness and equity and gave courage to the idea that Washington's insider game needs to be challenged. Ted Cruz put his principles ahead of immediate political gains by daring to oppose government support of ethanol in the critical first Iowa Presidential Caucus—and won! A bad policy has been clearly identified, opposition is not the political suicide that was once thought, but now the issue needs moral weight and political action. This paper suggests that fighting for an end to U.S. federal ethanol mandates may be an ideal social justice cause for students at U.S. Catholic universities.

For educators, the seven themes of Catholic Social Teaching (CST) form an excellent framework for bringing Catholic values and social awareness into the classroom as described by the United States Conference of Catholic Bishops (2005). These themes include the "life and dignity of the human person," the "dignity of work and rights of workers," an "option for the poor and vulnerable," and a "call to family, community, and participation." Global "solidarity" and recognizing the "rights and responsibilities" of Catholics to make the world a better place are other important aspects of CST. Finally, "Care for God's Creation" is an integral part of CST as summarized here:

> We show our respect for the Creator by our stewardship of creation. Care for the earth is not just an Earth Day slogan, it is a requirement of our faith. We are called to protect people and the planet, living our faith in relationship with all of God's creation. This environmental challenge has fundamental moral and ethical dimensions that cannot be ignored. (United States Conference of Catholic Bishops, 2005)

Of course the real challenge of CST is in implementation through personal action or public policy change. Refreshingly, young people in America in the 2016 election cycle seemed willing to call for justice and voice their opinions on other social issues. It is exciting to see the energy behind such movements as the call for a $15 minimum wage, Black Lives Matter, or the cessation of fossil fuel use—the later endorsed by Pope Francis in his 2015 Encyclical. (Winch, 2015). These big ideas may look good on television but how do they get translated into the construction of a more just society? All too often in academia and the political arena, legitimate conflicting perspectives make it unclear what actions and polices would actually improve the lives of the poor and oppressed in our society. Students want to affect change and get involved but are often unsure of what issues to back. To illustrate the complexity of doing the "right thing" we examine two popular social causes, the $15 minimum wage and ending fossil fuel use. The goal is to better understand the conflicts they present within CST, not to take sides. This underscores how important it is to find an issue which could gain more universal support. It does not help our faith or our reputation as educators to pursue agendas which create more angst than actual social improvement.

Complicated Issues

With anti-establishment messages resonating with voters and especially young people in today's

political climate, Pope Francis invited U.S. Presidential candidate Bernie Sanders to visit the Vatican to discuss issues of social justice. One of Sanders' touchstone ideas is the $15 minimum wage, which seems like an ideal social justice issue for Catholic groups and activist students to rally behind. Archbishop Thomas G. Wenski of Miami, Chairman of the U.S. Bishops' Committee on Domestic Justice and Human Development, has repeatedly called for higher federal minimum wages. It is hard to argue with the sentiment in a January 8, 2014 letter to the U.S. Senate, where he along with Father Larry Snyder, President of Catholic Charities USA, stated:

> The current federal minimum wage falls short... for its failure to provide sufficient resources for individuals to form and support families... Workers deserve a just wage that allows them to live in dignity, form and support families and contribute to the common good. (Sadowski, 2014)

There is a groundswell of support for raising the minimum wage nationally, and increasing to $15, as exemplified by rallies of Catholics and others such as the one in Rochester, N.Y. in April 2015 (Catholic Courier, 2015). However, economists raise some potentially legitimate counter arguments. Neumark & Wascher (2007) reviewed contemporary studies and found that while results were varied, higher minimum wages generally have a negative impact on employment levels. Most significantly from a Catholic social justice perspective, they found "overwhelming" evidence that the least- skilled groups of workers experienced unemployment due to minimum wage increases. Is the goal of the minimum wage to be high enough to "support families" or is it an entrance wage designed to give the young and others work experience and supplemental income? Imagine the small business person facing low profit margins, a limited payroll budget and $15 minimum wages; are they more likely to keep an educated and seasoned semi-retired 60-year old or a youth in training with limited skills? Considering the importance of work itself and the dignity of a job in CST, the risk of unemployment cannot be easily dismissed, especially if the poor and under-educated are the most vulnerable. In a blog at *The National Catholic Register,* Pat Archbold (2014) articulates this conflict well: "Can a Catholic oppose the minimum wage hike?" Archbold echoes the concerns of economists above and questions whether Catholic Bishops should be delving into complicated economic policy. His point was to "...establish that there is a legitimate debate as to its ($15 national minimum wage policy) efficacy. Moreover, while the goal is desirable, the outcome of such a policy may be counter-productive." In other words, if Catholics worked hard and succeeded in achieving the $15 minimum wage they could actually end up hurting the greater cause of social justice due to the unintended but somewhat predictable consequences of the policy on the most marginalized members of the workforce.

To address a second area of social activism more closely related to our primary topic of ethanol, there is the issue of ending fossil fuel use. Few would dispute the wisdom of the U.S. Catholic Bishops in 2001 who concluded their statement on global climate change with the following, "Even though energy resources literally fuel our economy and provide a good quality of life, we need to ask about ways we can conserve energy, prevent pollution, and live more simply." (United States Conference of Catholic Bishops, 2001, p. 15). More recently, as discussed in the New York Times, Pope Francis's encyclical on climate change, *Laudato Si*, directly blames excessive energy consumption and related environmental problems for the plight of the global poor and he calls for radical action (Yardley & Goodstein, 2015, p. A6). This has given momentum to a growing movement to divest financial investments in fossil fuels, as exemplified by students at the Catholic university Georgetown, who express on their website *Georgetown Fossil Free*:

> Fossil fuel and coal companies continue to pose a threat to public health, the global environment and human rights. While fossil fuel and coal production damages the environment as a whole, it has a particularly acute impact on the human rights and health of marginalized people of the United States and in the global south. (GU Fossil Free, 2016)

As documented by Roewe (2013), the fossil fuels divestment movement is growing at schools and in cities. She is not the first to compare the effort and moral imperatives to the successful disinvestment from all countries practicing apartheid in the last century, but the issue is not so simple. There is a

serious argument that fossil fuel discovery and use over the last 300 hundred years have led to unprecedented improvements in the quality of the world's health, quality of living and longevity. These lines of reasoning are well summarized in Alex Epstein's "Pope Francis's Crusade Against Fossil Fuels Hurts The Poor Most of All" (2015) and his book *The Moral Case for Fossil Fuels* (2014). To move to a specific advocacy issue for the poor, there is a concerted effort in Africa to replace wood burning cooking fires with Liquefied Natural Gas (LNG) or propane stoves (International Energy Agency, 2006). This effort has proven to reduce accidental fires, health problems from smoke, deforestation, and frees up women and children to do more than scavenge for scarce firewood. For example, The United Nation's WHO (World Health Organization) estimated that 1.3 million deaths a year are attributable to indoor air pollution from biomass wood fires (International Energy Agency, 2006). Even the use of fossil fuels to generate electricity is advocated by some, such as Kenny (2013), who argues that to improve air quality cooking fires and improve job prospects through modern industry, countries need electricity and natural gas which is cheaper and more abundant than solar, wind or other alternative methods of electricity production. When considering the seven themes of CST, there is strong emphasis on the condition of human life and the dignity of work for the poor. To sacrifice current progress in these areas for the future benefit of reducing human generated climate change is a worthy debate. Debate is healthy, especially on college campuses, and Larry Rasmussen, Normand Laurendeau, and Dan Solomon (2011) published "Introduction to the Energy Transition—Religious and Cultural Perspectives" in the Journal of Religion and Science to examine the complex nature of this issue. However, if we are looking for social action initiatives that unambiguously assist the world's poor, then we need to look elsewhere.

From a Catholic Education perspective, we seek an issue that can unify different student groups across campus and provide an outlet for students' desires to get involved in something that can truly help the poor. It would be helpful if the issue also had an anti-establishment theme, as that has been shown to energize and resonate with today's youth.

The Case against U.S. Ethanol Mandates

The remainder of this paper makes the rational case to end *U.S. Federal Ethanol Mandates*. This is an ideal movement to unify students, academics and social activists searching for a cause to broadly protest together. Ending U.S. federal ethanol mandates simultaneously embraces environmentalism, social justice, economic efficiency, and combats political cronyism. These mandates dictate that a large volume of ethanol must be blended into gasoline in the U.S., thus creating the standard "Contains 10% Ethanol" variety of gasoline that is sold across the country. Almost all ethanol in the United States is produced by heating and fermenting corn into what is essentially a grain alcohol fuel. By artificially increasing the global demand for corn, this U.S. policy was responsible for between 25% and 45% of the significant global increase in corn prices in the early part of this decade (Griffin, 2013). The policy has been a great example of corporate welfare, with billions of dollars of state and U.S. general tax funds going to large corporations and mega-farmers in subsidies. An entire Co2 producing supply chain of land use, fertilization, harvesting, transportation and processing has been artificially created to gain a presumed environmental benefit. Now the environmental value is almost universally doubted. Meanwhile, the most noticeable impact on common people is that they achieve fewer miles per gallon with their vehicles and pay higher food prices. This hits the poor hardest as they use a significantly higher percentage of their income for food and transportation. The working poor do not have the opportunity to take advantage of government subsidized electric Teslas (but that is another issue).

From a political perspective, the realization that ethanol production mandates are bad policy is nearly universal. For true conservatives, it is a classic case of government meddling in markets with negative consequences. In fact, Mario Loyola chose the issue as "A Simple Conservative Litmus Test" in the 2016 Republican Presidential primaries (2016). Liberal and "green" groups also oppose it; here is The Sierra Club's position: "The Club opposes further deployment of corn-based ethanol based on its extremely dubious net carbon benefits and its unresolved direct and indirect environmental impacts" (Cellarius, 2015). Political opposites Ted Cruz and Al Gore are both against further

development of corn based ethanol. Cruz opposed the Ethanol Renewable Fuel Standard mandate on principle during the Iowa caucuses, yet he still won. Al Gore recognized the "trivial" benefits of U.S. ethanol and according to a Wall Street Journal editorial, he told a gathering of energy financiers in Greece: "It is not a good policy to have these massive subsidies for first-generation ethanol…..it's hard once such a program is put in place to deal with the lobbies that keep it going." (Anonymous, 2010). The editorial went on to say: "Mr. Gore's mea culpa underscores the degree to which ethanol has become a purely political machine in the U.S.: It serves no purpose other than re-electing incumbents and transferring wealth to farm states and ethanol producers." As an anti-establishment issue, it fits the bill. The ethanol story is a good one for students at Catholic Universities to hear, and it is just as important to show that they can help write the ending.

The History of Ethanol and Policies in the U.S.

For a better understanding of U.S. government ethanol policies, it is necessary to look back at the history of ethanol fuel production and policy. The use of ethanol for fuel in the United States dates back as far as the auto industry itself, as Henry Ford's original Model T was made to run on any combination of ethanol and regular gasoline (Fuel- Testers, 2009). However, large-scale ethanol production and policies didn't go into effect until the late 1970s. Internationally, more extensive use goes back about 50 years further.

With the introduction of the automobile in Brazil in the 1920s, ethanol quickly became a prominent source of fuel. Brazil produces an abundance of sugarcane, which can be readily and efficiently converted into ethanol fuel. After World War II, global fuel prices declined significantly, reducing Brazil's need for alternative energy sources. This caused the sugarcane ethanol production to decrease significantly for the next 30 or so years. But when the first oil crisis hit in the 1970s, the industry immediately regained prevalence. Production was ramped up, and by 1976, it became mandatory to blend ethanol in fuel in Brazil (EthanolHistory, 2011).

Around this time, the United States was also actively seeking methods to increase energy independence and reduce susceptibility to overseas price fluctuations. Seeing the success that Brazil was having with their sugarcane ethanol, the United States was eager to get on board. Unfortunately due to differing climates, extensive sugarcane production in the US was not a feasible option, so the government was forced to go in a different direction. Corn seemed to be the next best option at the time, so the first policy was put into place to help get the industry off of the ground. The Energy Tax Act of 1978 established a $0.40 per gallon tax credit for producers of ethanol fuel, providing the first major incentive to enter this alternative energy market (EthanolHistory, 2011). Two years later, a $0.50 tariff was placed on imported ethanol in order to prevent the more established Brazilian industry from overrunning new domestic producers. In addition, prospective producers were granted government- guaranteed loans for up to 90% of construction costs. The government also allocated more money for corn ethanol research. All of these government actions had a profound effect on the industry in the following years, as ethanol production increased from 20 million gallons in 1979 to 750 million in 1986. These policies stayed constant for the most part until the turn of the century, although an additional $0.10 tax credit was applied for small scale producers in 1990 (Fuel-Testers, 2009).

It wasn't until the second Bush administration that the initial ethanol policies were significantly updated. By 2004, the country was producing 3.6 billion gallons of ethanol annually. Seeing this large increase from production in the early stages of the industry, the government enacted the Energy Policy Act of 2005. This mandated that 7.5 million gallons be produced annually by 2012. In 2007, the Energy Independence and Security Act was passed, which raised mandates to 9 billion by 2008 and a whopping 36 billion by 2022 (United States Department of Agriculture, 2014). These policies have recently been called into question due to the supposed lack of efficiency of corn ethanol itself.

The long-standing tariffs and tax credits expired in 2011, leaving the mandates as the sole incentive on the federal level to continue to increase production. Even the mandates are being revised, with an increasing amount of non-corn ethanol now required in order to meet them. This includes both sugarcane ethanol and cellulosic ethanol. Cellulosic ethanol is widely believed to be more efficient than its corn

equivalent, but this has led to overly optimistic projections, as the industry is still in its infancy. For instance in 2012, the original federal quota for cellulosic ethanol was 500 million gallons. Due to slower than expected growth of the industry though, this number had to be significantly reduced to 8.65 million gallons, less than 2% of the original target. Even with the revised target, producers did not come anywhere close, only producing a meager 20,000 gallons (Loris, 2013). As there is no alternative that can currently be produced on a large scale, corn ethanol production will likely continue.

Corn was supposed to be a temporary transition crop until more environmentally efficient cellulosic ethanol from straw, switchgrass and wood chips became produced in high volume. When this proved technologically challenging, there was no political will to modify or end the policy and the corn growers lobby argued strongly for the continued benefits of the RFS (Renewable Fuel Standard).

The most common blend of ethanol is called E10. E10 is comprised of 10% ethanol and 90% normal gasoline, and is sold at nearly every gas station nationwide. Though marginally less efficient than 100% regular gasoline, this blend is safe for use in all vehicles. But with the government-imposed mandates looming large and gasoline consumption in the U.S. growing slowly, simply making all gasoline 10% ethanol won't be enough. In order to meet the large quotas, higher percentage blends must be used. One option for this is the use of E85 (85% Ethanol) in the newer "flex-fuel" vehicles. These vehicles are designed to run on both regular gasoline and high percentage blends. Prices for E85 are typically lower than those of normal gasoline, but this is mostly nullified by the decreased fuel efficiency of high percentage ethanol blends, so owners of these vehicles don't always use E85 anyway. Even if E85 were to be used universally among flex-fuel vehicle owners, the mandate could still not be reached, as the vast majority of American drivers still own vehicles that do not support E85. Because of this, other methods must be pursued in order to increase ethanol consumption. Higher percentage blends have been tested in regular vehicles, and the government has deemed E15 (15%) ethanol safe for use in any vehicle from model year 2001 to the present (United States Department of Agriculture, 2014). Many are wary of this proclamation as other testing has shown there to be a "blend wall" above 10%, with engine damage occurring with the use of higher percentage blends (Loris, 2013). The validity of the "blend wall" assertion will be discussed in more depth in a later section, but this shows that the current federal mandates have caused blenders to push the supposed limit of ethanol that can safely be infused in our gasoline. While E15 hasn't gained prevalence nationwide at this point, many states in the Midwest with economies that depend on ethanol to varying degrees have made it readily available to drivers.

A map of ethanol processing plants in the U.S. shows Iowa as the epicenter with 40 plants, while Minnesota, Nebraska, Kansas, Indiana, Michigan, South Dakota and Illinois all have at least ten processing plants (U.S. Department of Agriculture, 2010). These states in the Midwest are a major obstacle to anyone hoping to decrease or repeal the mandates. Corn is one of the main products produced in the Midwest, and a significant percentage of that corn is used for ethanol production. Iowa in particular, with 73,000 people having ethanol-related jobs, makes it very difficult to change (American Coalition for Ethanol, 2015). With the honor of hosting the Iowa Caucuses as the first event of the presidential primary season, Iowa has the power to severely cripple the chances of any presidential hopeful who comes out opposing the mandate. Ted Cruz and Rand Paul were the only presidential primary candidates who dared to oppose continuation of the RFS. Cruz was subject to a multi-million dollar attack by the ethanol political group America's Renewable Future and Iowa Governor Terry Branstad worked to defeat him (Epstein 2016). Those following traditional political wisdom, including Hillary Clinton, Bernie Sanders, and Donald Trump chose to endorse a continuation of the RFS mandate.

Efficiency of Ethanol Production

Ethanol producers require both Presidential support for annual mandate level updates and Congressional approval for the renewal of the program overall in future years. Therefore, anything ethanol-related has been put under the microscope, including the methods of production. When examining these production methods, one important question arises. How efficient is the large scale production and distribution of ethanol? This question will be investigated from multiple angles, including the net energy gained

through the production of ethanol, the cost of production vs. the economic benefits and the viability of production in the absence of subsidies and quotas.

In order to create ethanol fuel, corn must first be transported to ethanol production plants. There, the corn is allowed to ferment and turn into ethyl alcohol. This alcohol, in turn, is converted into ethanol fuel. However, a heat treatment is required for these conversions, and this requires the use of additional fuel. The large amount of fuel that is required to produce ethanol fuel in the first place hints that its production may not be a very efficient process.

When considering the net energy gained through the production of ethanol, the most commonly used statistic is ERoEI, or Energy Returned on Energy Invested. For example, an ERoEI of 1:1 signifies that a fuel requires as much energy to produce as it provides as an output. However, ERoEI is not simply a concrete number that is universally agreed upon. Throughout the last ten to fifteen years, many studies have been done to calculate this number, and a wide variety of conclusions have been made. This wide range of findings is largely due to differing methodology among studies. For instance, secondary inputs are not consistently applied, byproduct is not consistently considered and even the estimates of universally applied inputs are far from identical.

A couple of extreme ERoEI calculations help to illustrate these differences. For instance, Cornell ecologist David Pimentel has done numerous studies that have shown an ERoEI of less than 1:1 (Lang, 2005). The most recent of these studies concluded that corn ethanol requires 29% more energy inputs than actual energy produced. This equates to a .78:1 ERoEI. On the other side of the spectrum, a 2010 USDA report asserted that corn ethanol production yields more than double the energy required to produce it, with an ERoEI of 2.34:1 (Rapier, 2010). Obviously, the methodologies used in these calculations differ greatly. Pimentel fails to give any consideration to the byproduct produced during the process, and uses high, outdated estimates of various inputs, including the amount of energy required to produce fertilizers used in production. The USDA on the other hand, excludes secondary inputs (the energy required to produce plants and equipment), and not only includes byproduct produced as an output, but also allocates a significant portion of the inputs to the production of the byproduct, which inflates the ERoEI substantially.

Though Pimentel's findings were relatively consistent with those of his previous studies, the extremely high ERoEI reported by the USDA was surprising due to the significant variance from its previous two studies. In their original study in 2002, the USDA reported that corn ethanol had an ERoEI of 1.34:1 (Shapouri, Duffield, & Wang, 2002). Standard calculations of their data (adding byproduct to the output side) would render a 1.27:1 ERoEI, but their fairly questionable method of subtracting the byproduct from the *input* side of the equation inflated their results by a small amount. The USDA also acknowledged in their following report that the 2002 study underestimated certain energy inputs. However, apart from these few issues, the method of calculation used in this study seems far more reasonable than that used in their following reports. Two years later, the USDA released another study to reassess this issue. After acknowledging that there had been underestimated inputs in 2002, one would think that the result would now be lower. That was far from the case. Instead, the 2004 reported ERoEI was 1.67:1 (Rapier, 2010). The cause of this was the implementation of the unique methodology that carried over to the 2010 study six years later. In 2004, the USDA started using the logic that because only the starch part of the kernel is converted to ethanol, and this accounts for about 66% of the kernel's mass, 34% of the energy inputs should be allocated directly to the production of byproduct. This arbitrary decision led to a significant increase in ERoEI, when in reality if the USDA had kept their methods from 2002, the ERoEI actually would have dropped slightly from 1.34:1 to 1.32:1 (or 1.27:1 to 1.26:1 using standard accounting). The fact that there was such a large reported increase, when in fact efficiency had remained stagnant or even decreased, seems massively deceptive to the public. Though from 2004 to 2010 improved technology had caused the industry to become more efficient, it hadn't become as efficient as the USDA would like the public to think it had. The reported ERoEI of 2.34:1 was a huge leap from the 2004 calculation, but when looked at using the 2002 methodology, this drops to a somewhat more reasonable 1.93:1 (1.69:1 using standard accounting) (Rapier, 2010). Though byproduct is an important

result of the corn ethanol producing process and will be discussed in more detail in the section on the effects on the food market, it is not used for energy, and ERoEI is a measurement of energy efficiency. Therefore, byproduct should not be considered in its calculation. When byproduct is not considered, the USDA data now results in ERoEI calculations of 1.09:1 in 2002, 1.06:1 in 2004 and 1.42:1 in 2010 (Rapier, 2010). Though secondary inputs have still not been taken into account, this paints a much more accurate picture of the energy efficiency of corn ethanol.

Recently, the generally accepted value has been around 1.3:1 (Maciel, 2006). The small difference from the most recent byproduct-excluded USDA calculation is likely due to the consideration of secondary inputs. While some of the methods of calculations used by the USDA seem to be out of place, their data still shows an unmistakable increase in the efficiency of the production of corn ethanol since the start of the 21st century. From 2004 to 2010, the energy required to produce a gallon of corn ethanol has dropped significantly from 72,052 BTUs to 53,785 (Rapier, 2010). Although by percentage this is a significant increase, the ERoEI of corn ethanol still sits far behind that of both sugarcane ethanol and standard gasoline.

When discussing the efficiency of the production of ethanol, it is important to weigh the specific costs and benefits of a pro-ethanol governmental policy, and quantify these costs and benefits economically as accurately as possible. The major quantifiable benefits of ethanol production include energy security and environmental benefits. Energy security benefits are derived from the reduced imports of foreign oil, while the environmental benefits relate to reduced greenhouse gas emissions. On the other hand, major quantifiable costs of government support of ethanol production include the extra cost of producing and distributing ethanol compared to petroleum, and additional costs of supporting and maintaining government incentive programs. In the 2009 article "The benefits and costs of ethanol: an evaluation of the government's analysis," written by Robert Hahn and Caroline Cecot, the authors attempt to compare these costs and benefits from a monetary perspective.

In their analysis, two separate scenarios were used. The article was written in 2009, so these scenarios assume that federal subsidies are still in place. As that is not currently the case, these costs will be subtracted from the article's original assessment. One scenario is based on the projected production with the continuation of the subsidies, called the "Energy Information Administration scenario". Without the subsidies, this is likely inaccurate at this point in time. The other more useful scenario is the "RFS scenario", which conversely projects production to continue at the pace to meet the 2022 mandate.

Of the previously discussed costs, the largest by far is unsurprisingly the cost to produce the ethanol fuel, at $820 million annually (Hahn & Cecot, 2009). Significantly, the other major cost is fairly shocking--the increased emissions of certain toxic gases/compounds. This combination of nitrogen oxides, volatile organic compound, particulate matter-10 and sulfur oxides comprises $365.6 million worth of costs. These costs total $1.186 billion (Hahn & Cecot, 2009). On the other side, the largest monetary benefit is the reduced oil consumption, quantified as $200 million in savings. Reduction of greenhouse gases and other "air toxics" are shown as a $103 million benefit. These benefits combined add up to $303 million. This is obviously substantially lower than the related costs, covering less than one third of them. Judging by this analysis, the cost of supporting ethanol production on the federal level far outweighs the benefit.

Engine Performance and Fuel Efficiency

Ethanol is widely reported to contain about 2/3 of the energy content of standard gasoline (Edmunds & Reed, 2009). Because of this, reduction in fuel efficiency is expected. This reduction is the most evident with the use of E85 fuel, but is also true of the common 10% ethanol blend. Based purely on physical properties, the energy content of the very common E10 contains only 96.7% of the energy content of non-ethanol gasoline. (U.S. Department of Energy, 2014). Due to this, it is reasonable to expect a similar reduction in fuel efficiency in E10. According to the US government, this is indeed the case, as FuelEconomy.gov reports that E10 provides 3-4% fewer MPGs than gasoline. Estimates elsewhere range from a 2-7% reduction, and while it is reasonable to think that the government may slightly understate the reduction to promote ethanol (as they have in previously discussed studies), the

energy content reduction suggests that their estimate is indeed accurate.

Though it is definitely true that E10 and E85 prices are currently lower than the price of standard gasoline, it has become increasingly evident that these reductions are at the very least offset by the decreased fuel efficiency experienced with ethanol-blended gasoline.

Impact on Corn Supply

While it is definitely important to compare ethanol to other fuel sources in terms of efficiency, performance and economic viability, there is another essential aspect to consider that is unique to this specific type of fuel. Standard gasoline's sole purpose is for use as an energy source. Corn, on the other hand, also comprises a substantial portion of human food consumption both domestically and abroad. Because of this, the impact that the reallocation of this resource toward fuel production has on the food supply must be thoroughly examined.

While estimates on the percentage of corn produced in the United States that goes toward ethanol vary significantly, it is quite clear that a substantial portion of the product is allocated for use as fuel. Two estimates in particular have been cited in numerous sources. The lower of the two approximates that 27% of the total annual yield goes toward ethanol fuel production, while the significantly higher second estimate states that 42% is directed to this use (Gorman, 2012). While these both constitute a significant portion of corn production, the stark difference between the two is important to investigate. Further analysis of these numbers shows that the 42% estimate solely considers the gross amount of corn that goes to the ethanol plant. However, the lower estimate also takes into account the byproduct of ethanol production that can be reused as an additive to livestock feed, which comprises a large portion of corn production itself. It is difficult to say which of these estimation methods has more merit, and the answer likely lies somewhere in the middle (Gorman, 2012).

Those who use the lower estimate are commonly advocates of ethanol fuel production. Due to the presence of the byproduct in the production process, this portion of the corn yield is allocated entirely to livestock feed in the same way that corn produced directly for livestock feed is (Gorman, 2012). This does not paint an entirely accurate picture. The specific byproduct, known as Dried Distillers Grains plus Solubles (DDGS), is far different than conventional feed produced from corn. DDGS has shown to be a beneficial additive to livestock feed, as it is high in protein and fat content, but much like ethanol fuel, it can only safely comprise a maximum of 10-15% of the feed (Harris, 2008). Due to this limit as well as storage limitations that arise by relatively quick molding and other storage-related difficulties, it is safe to assume that not all of the byproduct is able to be used given the very high volume that is produced during the process.

On the other hand, those who choose to display the 42% estimate are typically opponents of ethanol fuel production, or are at least against the large quotas put forth by the federal government. This estimate definitely paints a different picture than the lower one, but this is accomplished by completely ignoring the redistribution of the byproduct that is created during ethanol fuel production (Gorman, 2012). While it is true that this byproduct is not as useful as traditional corn-based livestock feed as discussed in the previous paragraph, it still definitely retains some value, and should not simply be considered waste as this gross percentage indirectly does.

While both of these methods have some merit, they both also have some flaws. The result is that the most accurate assessment likely lies somewhere between the two. Although this somewhat limited analysis cannot provide an exact number, it is probably safe to say that *roughly* one-third of the annual corn yield in the U.S. goes toward ethanol fuel.

Whether one chooses to base his/her assertions on the 42%, 27% or the likely more accurate middle ground, it is clear that ethanol production comprises a large chunk of the corn yield in the United States. This makes it very important to consider the effect that this has on food prices and hunger. While the direct impact is felt domestically, the United States' position as a global leader in corn production means that the global ramifications must be evaluated as well.

Impact on Food Prices and Domestic and International Hunger

While science, economics, and political students may appreciate inefficiencies of the RFS mandate

discussed to this point, all students should be sensitized to the plight of the global poor and starvation. When discussing the viability of the ethanol industry and its potential continued governmental support, perhaps the most important issue to consider is the ethical implications for the industry. With the substantial amount of the annual US corn yield that is currently diverted for use as fuel, (about 33% as discussed in the previous section), glaring questions arise with regard to possible food shortages and price increases both domestically and worldwide. Due to this, it is necessary to examine the effects that the ethanol fuel industry as a whole and current federal support for it have on food prices. This potential price inflation, in turn, may have a substantial effect on hunger both in the US and around the world.

Corn prices as well as prices of other important food items have increased substantially over recent years. Since the mandate-induced spike in ethanol fuel production in 2007, corn prices have more than doubled. In 2006/07, corn prices sat at $3.04 per bushel, while by 2012/13, they had jumped to $7.80 for the same amount (Griffin, 2013). Prices of dairy, wheat and food in general have experienced very similar increases in that time period, while meat prices, though to a lesser extent, have also increased substantially. The corresponding increase in the amount of corn moved toward fuel production over that time period is an obvious factor in this increase, but other factors during this window have also played a role, and thus isolating the exact effect of increased ethanol production has proven difficult. However, in James M. Griffin's extensive 2013 study on the possible reconsideration of current US ethanol policy, he attempts to do so.

The correlation between ethanol production and corn prices seems obvious, but the subsequent increases in wheat, dairy and meat prices may not seem to be as clearly related at first glance. However, upon further examination, these effects can be adequately explained. The increased ethanol production, especially following the 2007 mandate, has led to a higher percentage of US farmland being used for corn production. This has diverted both land and resources away from the cultivation of other crops, namely wheat. This decreased supply of wheat, along with the growing demand for wheat as a substitute for increasingly expensive corn products, has pushed wheat prices upward both domestically and worldwide. Additionally, apart from human consumption, corn is widely used in livestock feed. With these increasingly expensive inputs for both meat and dairy producers, higher costs are eventually transferred to consumers of these products.

While these price increases coincide almost perfectly with the sharp increases in ethanol fuel production, other factors must be considered. The rapidly growing economies of developing countries around the world have resulted in increased demand for certain food products abroad. The most significant example of this is the increased demand for US soybean exports to China. Between 2005 and 2010, the amount of US farmland dedicated to Chinese soybean exports rose from 8.3 million acres to 22.8 million (Griffin, 2013). Though this does not quite match the increase in farmland devoted to corn ethanol production within that timeframe, it is very close, and thus has a very similar effect on wheat prices. This recent spike in wheat prices can also partially be attributed to mandated biofuel production in other areas of the world. Particularly in Europe and Brazil, increasing amounts of farmland are being used for fuel production in the form of sugarcane, rapeseed and soybeans. Yet another factor influencing the price of corn has been the increasing price of fertilizer. From 2000 to 2010, the cost of fertilizing a bushel of corn increased from $0.33 to $0.76. However, the magnitude of the overall increase in price per bushel over that time period ($2.48), along with the fact that these rising fertilizer prices can likely at least be partially attributed indirectly to the ethanol mandates themselves, show the effect of this particular factor to be minimal.

In his article, Griffin uses previous studies to aid in his attempt to isolate the specific effect of the corn ethanol mandate on food prices in the presence of these other factors. He states that these are not intended to constitute a consensus, but to provide a fairly accurate range of the presumed impact. The first outside study cited is one conducted by the International Monetary Fund, which estimates that the federal mandates in the US account for somewhere between 25% and 45% of the global increase in corn prices. Next, he discusses a study run by the chief economist of the USDA, Joseph Glauber, who concluded that the current US policy contributes to about 25% of the increase.

However, these studies were conducted between 2008 and 2009, and both ethanol production and food prices increased significantly in the time since, although corn prices have moderated more recently. Because of this, it is reasonable to assume that these percentages have increased in the following years. Using this existing information and making his own attempts to separate the effects provided by the other aforementioned factors, Griffin believes that a minimum of 25% of global food prices can be attributed to ethanol policy in the US. This seems to be a logical conclusion, as the effect on global corn prices are likely substantially higher than that at this point in time, and the subsequent effects on other food products, though not quite as direct and substantial, seem evident enough to support this number. Even if the effect were to be attributed evenly among the other major factors put forth (which would likely still constitute a conservative estimate), the result would be that a quarter of these increases can be traced back to domestic ethanol production.

Given the clear correlation between the ethanol policies in the United States and increased food prices, the effect that this has on the poor is important to examine. In the United States, this impact is noticeable, but not nearly to the extent that it is in developing countries worldwide. The average working American spends 11.4% of their disposable income on food. This percentage is substantially larger among the poor in our country, but Americans have the luxury of having many readily available substitutes when the price of a particular food item significantly increases. There are the options of consuming more processed foods, or turning to inexpensive fast food options. While these consumer decisions clearly have an adverse effect on health, evident in the obesity rates among lower-class Americans, hunger does not become a huge issue.

Even with these substitutes available though, the consumer price index for food in the U.S. increased 17.8% from 2007 to 2012, accounting for an aggregate additional expenditure of $177 billion annually (Griffin, 2013). Even if only 25% of this number is attributed to corn ethanol policies, that still implies a $44 billion annual increase, which can be broken down to $383 per household. While this does not seem like a huge loss to most middle-class citizens, it is still a substantial constriction of already tight budgets among the poor in our country.

While there is clearly a marked effect domestically, it is fairly insignificant when compared to the effect on developing countries around the world. In these developing countries (Kenya, Pakistan and Cameroon are specifically cited in Griffin's article), the average citizen spends at least 40% of their income on food. When prices rise as sharply as they have in recent years, the poor in these countries don't have the readily available substitutes to turn to as those in the U.S. do. As a result, significant increases in these prices such as a 67.4% increase in the price of cereal grain just in the year 2011 led to the poor simply having to consume less. The Food and Agriculture Organization of the United Nation estimates that almost 70 million people worldwide have been plunged into severe poverty by rising food prices just in the small 2010-11 timeframe. With malnutrition already accounting for over 1/3 of childhood deaths globally according to UNICEF, price increases of this magnitude can have devastating effects, pushing even more of the less fortunate children around the world into malnourishment and starvation. While the 17.8% increase in the consumer price index for food in the U.S. is substantial, the IMF and UN both report that this increase has been much greater worldwide, with estimates ranging from 33.3% to 39%. While the previously outlined example deals with wheat prices, a more indirect result of corn ethanol policies, corn specific examples exist as well. Right around the 2007 institution of the US ethanol mandates, the "Great Mexican Tortilla Crisis" occurred. Corn tortillas are an important component of the diet in Mexico, especially among the poor who get almost half of their protein from them. While not quite at the level of those in developing countries, Mexicans still spend 22.7% of their income on food, a number that is likely even greater among the poor. When prices of these tortillas doubled (tripled in some areas), many of the poor who survive on low $4.14 daily minimum wages were not able to avoid severe hunger. This was evident in the tens of thousands of people who came out to protest these huge price increases (Griffin, 2013).

Conclusion and a Call to Action

While a drive to end the Renewable Fuel Standard (RFS) that mandates continued ethanol production in the U.S. is not as exciting as calls for the $15 minimum wage or free college tuition, it may well be

an issue that can unify students and professors with different political and economic perspectives. Ending the policy correlates with many of the CST themes, including assisting the global poor and improving the environment. There is support from both sides of the political spectrum to end the RFS policy. A Wall Street Journal editorial stated that the problem, as Al Gore put it, is that "It's hard once such a program is put in place to deal with the lobbies that keep it going." (Anonymous 2010). This is the perfect example of the "Washington establishment" that frustrated people in the 2016 election year and makes ethanol an attractive hot button issue for young people. Let's review the evidence of this failed policy before discussing steps to integrate it into an educational and social action agenda.

Aside from the inherent benefit of being a renewable and domestically produced energy source, ethanol production and the supportive U.S. mandate have been shown to have some positive aspects. While not to the extent of other fuels, corn ethanol does contain more energy than is required to produce it and reduces greenhouse gas emissions. As a high-octane fuel, ethanol provides more power to engines that are able to properly utilize it. With the mandate requiring high levels of production, many jobs have been created in the Midwest, and rapidly rising corn prices have resulted in increased prosperity for farmers.

However, almost every one of these benefits can be connected with an equal or greater cost. Though corn ethanol does produce more energy than is needed to make it, this is only a slight increase in energy content, making it extremely inefficient when compared to other fuels like sugarcane ethanol and standard gasoline. As shown in the cost/benefit analysis of corn ethanol, the reduced greenhouse gas emissions are more than offset by the increased emissions of other toxic chemicals into the air. Blending corn ethanol into gasoline has led to a small decrease in gas prices, but consumers don't receive any value from this, as the reduction in fuel economy causes consumers to pay as much or more than before. Most engines are not calibrated to take advantage of ethanol's higher octane levels and ethanol can actually cause damage to older Engines (Fuel-Testers, 2014). The federal mandate and the subsequent corn price spike has created jobs and increased profits for farmers, but this has all come at the expense of increased consumer costs in the U.S. and more importantly, increased starvation risk in developing countries.

When all of the benefits and drawbacks of federally mandated ethanol production in the United States are considered, it becomes evident that the cons clearly outweigh the pros. It is reasonable to conclude that the U.S. federal ethanol mandate that was enacted in 2007 is bad public policy. Current production levels already present many problems that have been detailed in this paper, so the significant increases that would be required to reach the mandate of 36 billion gallons by 2022 would only magnify these inefficiencies and further augment the already devastating effect on the world's poor. If the mandate were to be ended, the industry could still attempt to survive on the open market and preserve its jobs, but the economic analysis showed that this would be difficult. Thus, there may be a smaller and more efficient market for ethanol, so it is important not to oversimplify: "Ban Ethanol" is not the goal. The goal is to end the overreaching federal mandate that demands ethanol production at levels that reduce efficiency, cause pollution and have many unintended negative side effects.

As educators, this issue represents an opportunity for teaching and action. In addition to introducing Catholic Social Teaching, this topic makes science and economics approachable. The idea that a gallon of ethanol does not appear out of thin air to help reduce our oil dependence is easy to teach. Corn must be grown with tractors, fertilizer, and land. Corn and ethanol must be transported in fuel consuming trains or trucks and the process of making ethanol requires energy intensive heating.

The idea of cost benefit analysis is detailed in this paper, and when additional pollution is added, it becomes clear that this well intended government policy actually has net negative effects on both the environment and the poor. Good intentions don't automatically lead to good policy and good outcomes; this is a very important truth for students to grasp. Another teaching point is that economics and politics don't easily bow to the idealism of social justice and helping the poor. When a government policy artificially increases the demand for a food stock like corn, the laws of economics point to only one result: higher prices.

Once understood, this is an issue that can be acted on at many levels.

First, individuals who care about this issue should use only ethanol free gasoline in their cars. Universities can specify that the fuel they purchase for fleet use be ethanol free. When political candidates attend universities, students can ask questions or show signs that demonstrate to the political class that there is a growing awareness of the costs of the RFS ethanol mandate. More aggressively, a repeal of the RFS can be requested.

However, it might be far easier politically to work toward blocking RFS renewal after it expires in 2022. Senators running in 2018 will serve through 2024; how many will commit to simply not voting for further mandates? An ambitious professor or class could build a website and start a social media campaign raising awareness of this issue. For those looking for a practical and teachable focus to harness the energy of our youth that has been ignited by the 2016 Presidential campaign, perhaps "end the ethanol mandate" will become a well-known rallying cry. Catholic Universities are well positioned to successfully lead this effort.

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