WORKING PAPERS ON
CAPITAL AS POWER

No. 2014/03

The Ethanol Boom and the Restructuring of the Food Regime

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July 2014

http://www.capitalaspower.com/?p=1275

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A shorter version of this manuscript

is forthcoming at The Journal of Peasant Studies

Abstract

The agrofuel boom has brought about some of the most significant transformations in the world food system in recent decades. A rich and diverse body of agrarian political economy research has emerged that elucidates the conflicts and redistributional shifts engendered by these transformations. However, hitherto this point, less attention has been given to differences *within* agri-food capital. This paper contributes to the existing literature on agrofuels, by showing how one cluster of agri-food corporations and farmers within the US have benefited from soaring ethanol production at the expense of another cluster. More specifically, by adopting the method of disaggregation found in the capital as power approach, I delineate and chart the power trajectories of two corporate-led distributional coalitions that have vied over the course taken by the US ethanol sector: the 'Agro-Trader nexus' and the 'Animal Processor nexus'. My main finding is that the US ethanol boom has been a vector of redistribution: increasing the earnings of the Agro-Trader nexus and Corn Belt farmers while reducing the earnings of the Animal Processor nexus and livestock farmers outside of the Corn Belt. This finding points to the limits and contradictions of agrofuels capitalism and the acute tensions that exist at the heart of the corporate food regime.

'The trick is always to own the tollgate.'

Dwayne Andreas (former CEO of the world's largest ethanol producer – Archer Daniels Midland), in response to an associate who inquired about the secret of his business success (cited in Kahn 1991, 244).

[1] I would like to thank Jonathan Nitzan, Mark Peacock and Peter Gibbon for their very helpful comments. I am also extremely grateful to Daniel Lech of the National Agricultural Library in Beltsville, Maryland for granting me access to the invaluable archival material at the library during four research trips from 2012-2013. Thanks are also due to Eric George, Jeremy Green and Sandy Brian Hager. Finally, I would like to acknowledge Ontario's Ministry of Training, Colleges and Universities for awarding me an Ontario Graduate Scholarship in support of my research. The usual disclaimers apply.

Introduction

The surge in the production of agrofuels in general, and US ethanol in particular, represents one of the most significant transformations in the world food system in recent decades.[2] After a series of government initiatives to support the ethanol sector from the early 2000s onward, the diversion of corn into the US's agrofuel feedstocks increased dramatically. In 2001, US ethanol production accounted for 34% of global production of agrofuels. Ten years later this figure rose to 48%.[3] The American ethanol sector is now so large that it consumes around *two-fifths* of the corn produced in the US. The re-channelling of grain from food production into fuel production has, according to many analyses, been a chief contributor to rising food prices since the beginning of the twenty-first century. A leaked World Bank internal report estimates that 70-75% of the food price rises between 2002 and 2008 were caused by the absorption of grain into burgeoning global agrofuel feedstocks; and a study by researchers at the New England Complex Systems Institute contends that the US ethanol sector alone was the preponderant long-term driver of food price inflation between 2004 and 2011 (Mitchell 2008, Lagi *et al.* 2011). These food price hikes have had stark impacts. According to one estimate, the 'real' price paid by the world's landless poor for the world's major calorie staples has doubled since 2004 (Wright 2014).

The wrenching changes brought about by soaring ethanol and biodiesel production (see Figure 1) have prompted some scholars to ask whether the categories and methods of agrarian political economy are adequate to the task of analyzing the agrofuel boom. In an important overview of 'agrofuels capitalism', Ben White and Anirban Dasgupta address this issue directly. They suggest that the existing tools of analysis offered by agrarian political economy can be used to explain the agrofuel boom, just as these tools help to explain expansions in large-scale, monocrop agriculture in the past. A political economy approach, they argue, focuses our attention on 'the social relations of production and reproduction and the structures of accumulation or (dis)accumulation' generated by agrarian change, and the 'accompanying processes of social differentiation and class formation' (2010, 600). This focus, they contend, is encapsulated by Henry Bernstein's catechism: 'who owns what? who does what? who gets what? what do they with it?' In the case of agrofuels, White and Dasgupta suggest that Bernstein's formulation can be distilled into the following three questions: Where does the land for the growing of agrofuel feedstocks come from? How is agrofuel production organized? And for whose benefit? In seeking to answer these

[2] Following Philip McMichael and other analysts of the biofuel boom, I label biofuels 'agrofuels' to underscore the problematic diversion of agricultural products from food to fuel uses. The commercial agrofuels sector is currently in large part restricted to first-generation agrofuels made from the starches, sugars or vegetable oils extracted from arable crops. Second-generation agrofuels made from non-edible plant biomass and third-generation agrofuels made from microalgae are still under commercial development and as a result only account for an estimated 0.04% of US agrofuel production. Author's calculations from US Department of Agriculture data (USDA ERS 2014a).

[3] Author's calculations from US Energy Information Administration data (2013) .

questions, White and Dasgupta contend that we will establish 'the actors involved and the added value in different points in the agrofuels commodity chain, the power positions and relations of the various actors, and the role of external agencies, including government' (2010, 605).

A significant amount of agrarian political economy research has advanced the project of disaggregating the various actors and interests involved in the agrofuel boom (Borras *et al.* 2010). These contributions offer rich insights in regard to the conflictual and redistributional dynamics brought about by soaring ethanol and biodiesel production, at a variety of social scales. The broadest and most wide-ranging appraisal of the agrofuel boom is perhaps offered by Philip McMichael. In his macroscopic analysis, McMichael (2009a, 2009b, 2010, 2012) combines a world-historical conception of capital accumulation with important observations garnered from case-study investigations of the agrofuel boom. From this vantage point, one can discern a food/fuel complex around which a socially and ecologically unsustainable food-for-fuel regime may be taking shape. Moreover, some scholars offer detailed examinations of how the broad processes of capital accumulation and peasant displacement, outlined so well by McMichael, play out in terms of regressive redistribution within regions (Dauvergne and Neville 2009, 2010; Richardson 2010, 2012), while others focus on the redistributional shifts, land-use changes and struggles around agrofuel development at the national level (Carolan 2009, 2010, Novo *et al.* 2010, Wilkinson and Herrera 2010, Holleman 2012, Mintz-Habib 2013). Crucially, there are also a number of fine-grained analyses of the differentiated ways in which agrofuels development impact, and are mediated by, local agrarian class structures and ethnic divisions (Gillon 2010, Vermeulen and Cotula 2010, Borras *et al.* 2011, McCarthy *et al.* 2011, Bain *et al.* 2012, Bain and Selfa 2013, Montefrio and Sonnefield 2013, Selfa *et al*. 2014). And finally, some scholars have extended agrarian political economy's focus on conflict and social differentiation to the domain of gender relations, by examining both the variegated effects that expanding agrofuels production have had on men and women and the uneven ways in which male and female labour is commodified and valued (Rometsch 2012, Julia and White 2013).

These contributions affirm the importance of the agrarian political economy framework to our understanding of the agrofuel boom. Not only does this body of literature successfully differentiate between the interests and roles of various rural social constituencies in regard to ethanol and biodiesel production, it also offers significant insights in regard to the ways in which corporations work with government to institutionalize agrofuels capitalism. However, hitherto this point, less attention has been given to differences *within* agri-food capital. As such, the analysis offered in this paper seeks to contribute to existing research by extending the agrarian political economy project of social disaggregation more

explicitly to the domain of agribusiness.[4] More specifically, I suggest that through drawing on the method of disaggregating capital accumulation and labor income found in the capital *as* power (CasP) approach, we can make better sense of the struggles between corporate-led coalitions over the future trajectory of agrofuels capitalism. And in so doing, we can discern sources of tension within the corporate food regime and the limits and contradictions of agrofuels capitalism as a whole.

The investigation focuses on the US ethanol sector as it is the global epicenter of the agrofuel boom (see Figure 1). More specifically, I identify and analyze two rival constellations of corporate power within the US food system. The first is the Agro-Trader nexus. The core of this nexus comprises one of the world's largest grain processors along with a triumvirate of agricultural input firms. The second is the Animal Processor nexus. This constellation comprises the major firms that oversee the conversion of animal life into meat products. The feed grain sector lies at the interstices of the Agro-Trader nexus and the Animal Processor nexus and, as a result, it has become a site of redistributional conflict for the two business configurations. As I argue, the corn-ethanol boom has been a manifestation of this struggle. More specifically, soaring corn-ethanol production has shifted the balance of feed grain prices in a way that benefits the Agro-Trader nexus and Corn Belt farmers to the detriment of the Animal Processor nexus and livestock farmers outside of the Corn Belt. Concomitantly, while the Agro-Trader nexus and corn growers have championed government support for the corn-ethanol sector, the Animal Processor nexus and most livestock farmers have opposed it. Thus, changes in the relative price of feed grain on the one hand, and changes in the relative power of the Agro-Trader nexus and the Animal Processor nexus on the other, are two sides of the same process of redistributional restructuring and social differentiation in US agribusiness and agriculture.

Why does this analysis matter? Most importantly, it offers a nuanced understanding of the power dynamics that surround the corn-ethanol boom. As I argue, many analyses of agrofuels capitalism chiefly examine the power relations *between* agri-food capital and agricultural producers, arriving at the broadly true, but now oft-stated, conclusion that the former is increasingly dominating the latter. My method of tracing the uneven distributional consequences of the ethanol boom within agriculture and within agribusiness adds important details to the analysis of agrofuels development because it helps the researcher cut *across* the agribusiness/agriculture divide to show how one cluster of farmers and agri-food corporations appears to be benefiting at the expense of another. By specifying the winners and losers of

[4] A note on terminology: 'agribusiness' is widely understood as comprising agricultural input firms. However, in this paper, I use the term interchangeably with agri-food capital. As such 'agribusiness' denotes not only agricultural input firms, but also processing firms, trading houses and food manufacturers. The conceptualization coheres with Davis and Goldberg's (1957) original definition. Furthermore, 'livestock' is commonly understood to include cattle and hogs, but not poultry. I adopt a broader definition of livestock that is inclusive of this latter category of domesticates.

the agrofuel boom in this manner, the paper casts light on the uneven geography of agricultural development within the US and it also points to the social forces that stand to gain from the continuation of large-scale corn-ethanol production. As my findings indicate, putting an end to corn-ethanol production would not only involve challenging the accumulation strategies of some of the most powerful agri-food corporations in the world, it would also necessarily entail addressing the interests of a large constituency of monocropping farmers within the Corn Belt that benefit from the ongoing diversion of agricultural products into agrofuel feedstocks. More broadly, the paper points to the potential of conducting research in other areas of agrarian political economy, on the ways in which redistributional struggles within agriculture become co-articulated with redistributional struggles within agribusiness. Such research may contribute to existing understandings of the dynamics of inclusion and exclusion, and resistance and incorporation, in the relationships between farmers and agri-food capital.

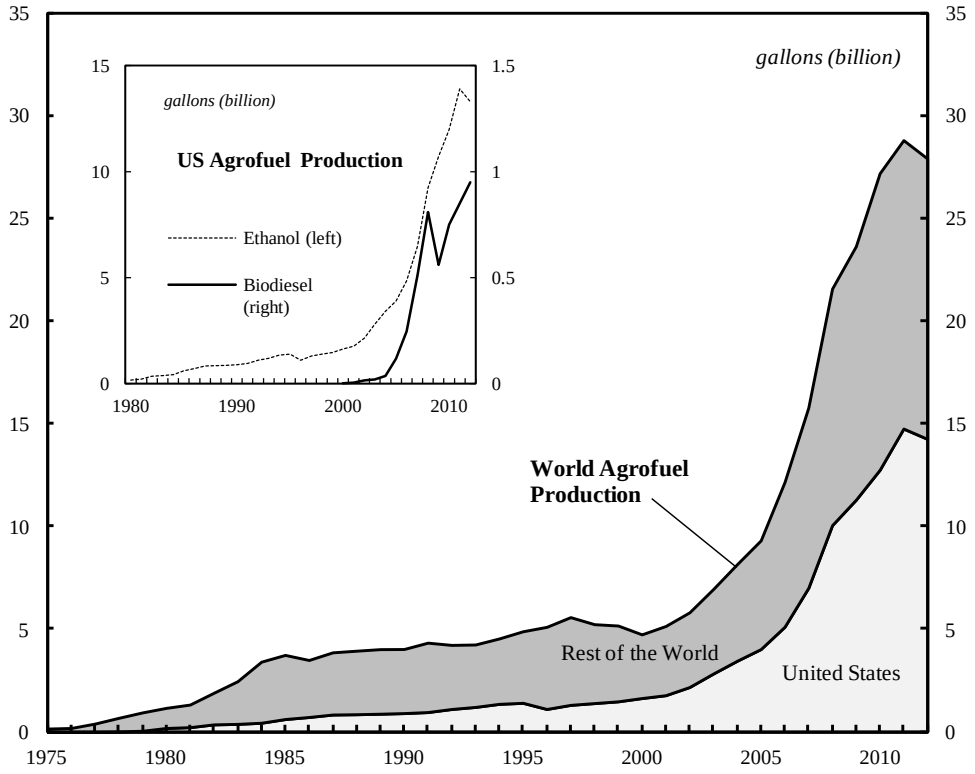

Figure 1: Agrofuel Production in the US and the Rest of the World

Source: 1975-2010 data from the Earth Policy Institute (2014). 2011-12 data from Worldwatch Institute (2014)

The paper comprises three sections. The first section takes Philip McMichael's account of agrofuels as its point of departure. As I have already suggested, the importance of McMichael's work lies in its situating of soaring ethanol and biodiesel production in relation to the world-historical dynamics of capital accumulation. In this respect, his analysis offers an important analytical map that helps orient those researchers conducting investigations on agrofuels at regional, national and local levels. However, by virtue of the wide-ranging scale at which he navigates the changing global food-fuel landscape and by virtue of his aggregative outlook on capital accumulation, McMichael tends to underspecify the redistributional conflicts *between* corporations over agrofuel production. This under-specification is typified by his assertion that agrofuels represent a 'portal' for the increased profitability of 'capital in general'. As I argue, although the concept of 'capital in general' is useful for elucidating the broad transformations in the food system, it tells us little about the contending agribusiness-agriculture alliances that vie over the course taken by the agrofuel sector. The second section outlines aspects of the CasP approach. Particular attention is given to the methods and concepts offered by the framework to specify the processes of (dis)accumulation within agribusiness and the processes of social differentiation within agriculture. The third section draws on both the food regime approach and the CasP framework in putting the ethanol boom of the early twenty-first century into historical perspective. Moreover, it outlines how commodity-crop production and animal-meat production have become more or less distinct sectors of corporate control. And it then examines how the ethanol boom is constitutive of a conflict between these two sectors. As I show, while the US ethanol boom may have increased the profitability of capital in general, it has also been a vector of redistribution: increasing the earnings of the Agro-Trader nexus and corn growers while reducing the earnings of the Animal Processor nexus and livestock farmers outside of the Midwest. In the conclusion of the paper, I discuss the implications of these findings.

The food regime analysis of agrofuels

McMichael's analysis of the agrofuel boom is primarily anchored in the food regime framework. The framework was propounded by Harriet Friedmann (1987) and it received further substantiation two years later in a landmark article that she authored with McMichael. In this article, Friedmann and McMichael (1989) identify stabilized relations in the production, trade and consumption of food, from the period of high colonialism onwards. These stabilized relations emerge out of particular balances of social forces, within and between imperial metropoles, colonies and settler-states, and then later within and between advanced capitalist countries and the newly decolonized nations of the Third World. The approach combines a world-systems theory perspective on geographical specialization with a method of periodizing capitalism derived from the French Regulation School. Added to this theoretical synthesis is a focus on

the evolution of various agri-food complexes that connect farmers to consumers through various webs of supply chains (Friedmann and McMichael 1989, Friedmann 2009, McMichael 2009a).

Friedmann and McMichael originally identified two food regimes. The first food regime was centered on British hegemony in the late nineteenth and early twentieth centuries. It combined the sequestering of exotic goods from tropical colonies with the importation of basic grains and livestock from the more temperate settler states, the most important one of which was the US. The cheap prices ensured by this imperial arrangement enabled rapid industrialization in the metropolitan heartlands of capitalism. However, the first food regime ran into social and ecological limits. Highly fertile ecosystems became exhausted by soil-mining. Moreover, family farmers were, by the 1920s and 1930s, becoming increasingly exposed to the exigencies of a depressed world market. The deleterious effects of this food regime were perhaps most starkly exposed by the overlapping social and ecological catastrophes of the Great Depression and Dustbowl. Vast swathes of rural America were denuded by drought and hundreds of thousands of farmers stripped of all means of earning a decent income (Friedmann and McMichael 1989, Friedmann 2005). The second regime was centered on US hegemony and it emerged out of the social and environmental dislocation of the 1930s. In this context, family farmers within the US resolved to build a powerful constellation of lobbying organizations to represent their interests. The resulting 'farm bloc' became an important force in US agricultural policy for over three decades. Indeed, having rallied behind the Roosevelt administration's New Deal in the 1930s, the farm bloc had won, and then defended, a suite of government measures – including price supports, production controls, tariffs and 'food aid' – that buffered agricultural producers from market instability. These government protections contributed to a provisional resolution of the social crisis that precipitated the first food regime's collapse.

Drawing on the analysis of agro-industrial development offered by David Goodman *et al.* (1987), Friedmann and McMichael identify two long-running processes that would eventually undermine the second food regime. Firstly, agri-food capitals intensified their *appropriation* of aspects of the agricultural process through the transformation of farming into discrete elements of business control. For example, by the 1940s, the farm-reared horse was almost completely replaced by the industry-manufactured tractor for tilling; and the recycling of organic waste, such as manure, into farm soil was rendered obsolete by the wholesale introduction of industry-produced fertilizers. Secondly, agri-food capitals intensified their *substitution* of traditional foods produced in the tropics, such as cane sugar and peanut oil, with derivatives of commodities that could be produced in more temperate climes, such as high fructose corn syrup and soybean oil. Friedmann and McMichael convincingly argue that these processes of appropriation and substitution enabled agri-food capitals to integrate the world food system by breaking agriculture into specialized sectors connected through supply chains that cut across national boundaries.

This dynamic was evidenced in the emergence of the transnational 'durable food complex' and the 'livestock-feed complex'. With the emergence of these complexes, agricultural production moved away from closed-loop processes of energy and nutrient recycling controlled by farmers, toward a linear process, comprising commodified inputs and outputs that were bought from, and sold to, increasingly powerful agribusiness firms (Friedmann and McMichael 1989, Weis 2007).

As agricultural production became more linear, farming became more specialized, more capital-intensive and thus less favorable to small family farm operations. These trends, in turn, contributed to a decline in the farmer population and the fragmentation of farmer interests along the lines of commodity specialization. Thus, the farm bloc was critically undermined, as broad-based agricultural lobbies that represented the interests of small farmers were superseded by commodity-specific interest groups that were principally driven by the interests of agri-food capital. As both Friedmann and McMichael argue, the decline of the US farm bloc, along with the intensification of international trade rivalries in the 1970s and 1980s, contributed significantly to the unravelling of the second food regime (Friedmann and McMichael 1989, Friedmann 1994, Friedmann 2005).

Given the food regime approach's proven capacity to clarify and orient analysis of the complexities of the political economy of food, it is no surprise that at the beginning of his most extensive exploration of agrofuels, McMichael uses the original framework as his guide. Having outlined the colonial and the US-centered food regimes, McMichael discusses the 'corporate food regime'. For McMichael, this corporate food regime has been constructed in the context of neoliberal hegemony. The key institution of this new food regime appears to be the World Trade Organization (WTO). As McMichael contends, the WTO has provided a 'multilateral façade' and it has at the same time, 'presided over a deepening of agribusiness power' (2010, 614). McMichael suggests that the agrofuels sector developed within the corporate food regime. However, its rapid growth may precipitate the corporate food regime's own demise, for by contributing to sharp food price rises in the 2000s, the agrofuel boom has undermined the neoliberal claim that food security can be attained through continued market integration and agro-industrialization. A new assemblage of agri-food relationships that approximate to a food-for-fuel regime may thus supersede the corporate food regime (McMichael 2010). This new regime is taking shape around the 'food/fuel complex': a network of recombinant corporate arrangements that combine the appropriation of agricultural processes by major seed companies, with the substitution of food for fuel, through alliances of grain, meat and energy companies (McMichael 2009b).

For McMichael, these recombinant corporate arrangements represent a profound epistemological assault whereby capitalist value relations are superimposed onto extant systems of provisioning. To cite him directly, 'the agrofuels "gold rush" reveals the one-dimensionality of value relations as embodied in

capitalism and its structures of thought' (2010, 622). Given his focus on 'structures of thought', McMichael enjoins agrarian political economists to relay the 'ecologically relevant discourses' that counter the 'value calculus through which capital rules the world' (McMichael 2010, 622-6). This project has a lot to recommend it. However, if we overlook the contestation between agri-food capitals, there is a danger that we may ascribe an unduly uniform metanarrative to capital accumulation itself. The tendency to underspecify the contrasting interests of agri-food capital may be adduced from McMichael's statement that the agrofuel boom:

> 'follows a typical capital accumulation script – that is, attempting to overcome barriers to profitability by extending the realm of value creation, even as this intensifies capitalism's contradictions… The 'agrofuels project' is central to this attempt to maintain profit, and to legitimize the state/capital nexus' (2009, 825-6).

The assertion that the 'agrofuels project' legitimizes a 'state/capital nexus' as a whole is instructive at a macroscopic level of analysis. Nonetheless, we should also be attentive to the fact that different corporations seek to justify their competing attempts at re-organizing the contemporary food regime with recourse to different, and oftentimes rival, claims to legitimacy. The tendency to de-emphasize the role of intra-capitalist conflict over agrofuels is further evidenced in his assertion that 'biofuels constitute another portal through which *capital in general* can profit from agriculture' (2010, 613, my emphasis). The issue here is that although 'capital in general' is a potent category from a systemic perspective, it does not tell us much about the redistributional struggles that are occurring *within* agribusiness over agrofuels production. Thus, even when McMichael does refer to individual corporations in his analysis of agrofuels (see for example2009b, 290-91), there is a danger that the reader may mistake these corporations as being mere standard-bearers of monolithic capitalist interests.

This paper seeks to develop the food regime account of agrofuels through a more concerted examination of intra-capitalist dynamics. Moving from McMichael's panoramic conception of 'capital in general' to a detailed investigation of different groups of agri-food capital, I seek to identify the winners and losers of the ethanol boom, within both US agribusiness and agriculture. In so doing, I address a number of key questions that are opened by the food regime approach to agrofuels, and by agrarian political economy, more generally: How has the increased specialization of US agriculture played out in terms of the political-economic dynamics of the contemporary food regime? How has the decomposition of agricultural production into discrete phases appropriated by agribusiness impacted social differentiation within rural America? How has the rendering of agricultural products into substitutable commodities used in both food and energy sectors impacted processes of (dis)accumulation within agri-food capital at large? And finally, what tensions within the food/fuel complex do these processes of social differentiation and

(dis)accumulation bring to bear? But before we delve into the empirical analysis of the US ethanol sector, we first have to establish methods and concepts that enable us to disaggregate capital.

Toward the disaggregation of agri-food capital

The CasP framework can contribute to the food regime approach in particular, and agrarian political economy more generally, because it furnishes the researcher with the means to chart the trajectories of different constellations of corporate power. The framework's disaggregative view of capital stems from the observation that the central institution of capitalism is private ownership and private ownership is predicated on exclusion. Without private ownership there can be no restriction on the use of goods; and without restriction on the use of goods, goods cannot be priced into commodities that yield pecuniary earnings. From this view, 'scarcity' does not spring seamlessly from nature; instead, it emerges through the medium of control (Nitzan and Bichler 2009).

A particularly important aspect of this control lies in different business groups' command over the interstices that link various parts of commodity chains. By means of discretionary management and, if necessary, disruption, the interstices can be levered by firms in such a way that changes the balance of prices to these firms' advantage, and to the disadvantage of firms that operate other parts of commodity chains (Veblen 1905, Nitzan and Bichler 2009). Such an analytical starting point compliments key aspects of the food regime approach. As I have argued, Friedmann and McMichael convincingly show that the appropriation of discrete phases of the agricultural process, on the one hand, and the fractionation of agricultural goods into substitutable commodities, on the other, has enabled agribusiness to integrate agricultural and food manufacturing processes within overlapping agri-food complexes on a world-scale. The CasP framework adds to these insights by underscoring the fact that control over distinct parts of agri-food complexes enables agribusiness groups to potentially rechannel flows of agricultural goods in ways that give them leverage over other agribusiness groups. And due to the ever-expanding system of prices, this leverage manifests in quantitative shifts in accumulation from one constellation of agri-food capital to another constellation.

Furthermore, while prices are the quantified appearances of exclusionary control over various parts of agri-food complexes, from the CasP perspective, the syntax that organizes prices into a totalizing system is capitalization: the risk-adjusted discounting of a future stream of earnings to its present value. A quick perusal of any corporate finance textbook confirms that the discounting formula of capitalization is elemental to the language of business. But one of the major innovations of the CasP approach lies in the fact that it rearticulates this discounting formula from the power perspective of what Nitzan and Bichler

call ‘dominant capital’: the firms and government entities at the center of accumulation. Capitalization is all encompassing. Any change in social organization that may bear on the expected future earnings of any given asset is factored into the capitalization formula. And since dominant capital strives to re-shape the interactions of human and non-human life in a manner that augments future income and reduces risk, market value is itself the master signifier of business power. This insight has far-reaching implications. Instead of being a mere tool that enables equity-holders to passively measure the value of their ownership claims, capitalization is the inter-subjective process whereby investors collectively translate dominant capitals’ power to actively restructure social reproduction into the universal symbols of dollars and cents (Nitzan and Bichler 2009, DiMuzio 2012).

Nitzan and Bichler concur with the food regime approach in taking accumulation to be an inescapably antagonistic process through which capital subjects the biosphere to a universalizing value-metric. However, their identification of capitalization as this metric opens up new ways of interpreting accumulation. Indeed, if capitalization is the metric of capitalist power, the social conflict inherent to accumulation exists on two levels. Firstly, it exists between different corporations as they attempt to re-organize social reproduction in their own specific ways; and the future stream of earnings that one firm can confidently claim is a future stream of earnings that all others cannot claim. Secondly, it exists between dominant capital and the biosphere, of which society is an integral part, as those subject to different corporate groups’ attempts at controlling agricultural supply chains persistently evade and oppose such control. Such evasion and opposition undermines the confidence that capitalists have in restructuring supply chains for their own pecuniary gain. As such, capital accumulation is nothing other than the augmentation of power. This power is articulated numerically in the form of the discounting formula of capitalization; and it asserts itself in qualitative terms through different corporations’ attempts at controlling the continuum of ecological and social processes that supply chains punctuate, in ways that boost their expected future earnings over and above the expected future earnings of other corporations (Nitzan and Bichler 2009).

Moreover, since power is relative, accumulation is differential. Following on from this presupposition, the CasP framework suggests that corporations tend to coalesce into different ‘distributional coalitions’ in a bid to enforce the necessary changes in humanity and nature to attain differential gain. Mancur Olson devised the concept of ‘distributional coalitions’ in his theory of collective action to denote small and exclusive groups of actors that focus on redistributing existing social product in their favor as opposed to increasing the overall social product. Owing to the exclusivity of distributional coalitions, the costs of increasing ‘the average’ – whichever way that may be denominated - are very large; but the benefits to the members themselves are very small. The concept of distributional coalitions is instructive for CasP

analysis, not least because it sheds light on how capitalist exclusion is institutionalized within business alliances. However, the CasP approach departs from Olson's schema in a number of important ways. Most fundamentally, whereas for Olson, power is merely a means to a utilitarian end, for CasP it is a goal in itself. Moreover, unlike Olson, the CasP approach focuses on the social damage caused by corporate-led distributional coalitions, rather than distributional coalitions *tout court*. Finally, unlike Olson, the CasP framework offers a systematic method of quantitatively mapping out the trajectory of these capitalist alliances. The method involves comparing the changes in the capitalization of any one group of firms within dominant capital against the changes in the average capitalization of dominant capital at large (Olson 1965, Nitzan 1992).

To summarize this section, from a CasP perspective, the 'value calculus through which capital rules the world' (McMichael 2010, 622) is differential capitalization. By understanding this value calculus, we can analyze the agrofuel boom in ways that build on existing agrarian political economy literature. My method comprises three steps. First, the researcher outlines the different corporate constellations and alliances that operate at the key interstitial points of the agri-food complexes that they are analyzing. Second, they chart the relative price changes of the commodities traded at these interstitial points, along with the corporate groupings' respective capitalized profit shares. Third, the researcher links these quantitative changes in relative prices and capitalized profit shares, on the hand, to the evolution of corporate alliances, on the other, to formulate an integrative, quantitative-qualitative analysis of the transformations in control over human and non-human life. And as I will show, we can extend this differential analysis to agricultural producers, by examining how the relative income of various commodity-crop farmers and livestock farmers shift in relation to the interstitial changes of the agri-food complexes in which they are ensconced. By examining both the shifts in differential capitalization of agribusiness groups and the shifts in differential income of agricultural producers, we can discern how power may be being redistributed from one cluster of agri-food capitals and farmers at the expense of another cluster.

This approach can contribute important details to the food regime analysis of agrofuels, in particular. McMichael tends to examine the power dynamics *between* agri-food capital and agricultural producers in his analysis of agrofuels, arriving at the broadly true, but now oft-stated, conclusion that the former is increasingly dominating the latter. The concept of distributional coalitions, along with the method of tracing the trajectories of differential capitalization of agri-food capital and differential income of farmers, may add nuance to McMichael's analysis because it helps the researcher cut *across* the agribusiness/agriculture divide. And in so doing, the researcher can discern power shifts between different agribusiness-agriculture coalitions. In what remains, I combine the food regime approach's analysis of

evolving agri-food complexes with the CasP approach's focus on relative prices and relative pecuniary gain, in my analysis of the US corn-ethanol boom. More specifically, I explore the political institutionalization and oligopolistic dynamics of the modern food/fuel complex as it pertains to the US ethanol sector. I then identify two constellations of firms and farming groups that have vied over the course of the food/fuel complex during the 2000s. And finally, I show how this struggle has manifested in a structural shift in feed grain prices and a radical divergence in the pecuniary trajectories of the two corporate-led coalitions. By shedding new light on the processes of social differentiation and (dis)accumulation engendered by the agrofuel boom, I seek to demonstrate how a synthesis of the food regime approach and the CasP approach may help advance the project of disaggregation within agrarian political economy.

The rise of two axes of agribusiness power in the corporate food regime

i) Archer Daniels Midland and the political institutionalization of the US food/fuel complex

The conversion of plant biomass into transportation fuel has a long history (see Carolan 2009). But thefood/fuel complex that exists in the US today emergedin the 1970s, following three decades in which ethanol was completely marginalized as a source of energy. The renaissance of the ethanol sector was made possible by extensive government subsidies and the assiduous lobbying efforts of one firm: Archer Daniels Midland (ADM). To cite one analyst, '[p]erhaps no commodity in American history has depended more on government support for its viability than ethanol. And perhaps no other company has done as much to orchestrate Washington's current support for the fuel than ADM' (Palmer 2006, 1). ADM's successful championing of the food/fuel complex took place against the backdrop of two key developments. Firstly, gasoline prices were soaring as a result of the transition of Middle East oil production from a 'free-flow' regime to a 'limited flow' regime (see main chart of Figure 2).[5] Secondly, just as controls over Middle East oil production were being tightened, controls over US grain production were being loosened. This general loosening of government regulations over agricultural production was in large part a result of the fracturing of the farm bloc and the coeval rise in the power of agribusiness (Feedstuffs Magazine 1968, Friedmann and McMichael 1989, Friedmann 2005). The passing of the 1973 Farm Bill was a key turning point as it initiated the dismantling of the comprehensive system of agricultural price supports that had existed since the New Deal era. Set-aside controls were suspended, public grain reserves were emptied, prices were allowed to fall below the cost of production, and farmers'

[5] For an analysis of how oil price inflation is linked to the rise and fall of various distributional coalitions in the global political economy see Nitzan and Bichler 2002.

incomes were now supported by direct payments from government (Winders 2009, Lehrer 2010). No matter how much market prices fell, farmers could keep on producing more, safe in the knowledge that they would receive direct payments that would make up the difference between the prices they got for their crop and the 'target prices' set by the US Department of Agriculture (USDA) . As the left insert of Figure 2 shows, the amount of US land devoted to corn production subsequently increased after a four decade decline. Wheat production also rebounded.

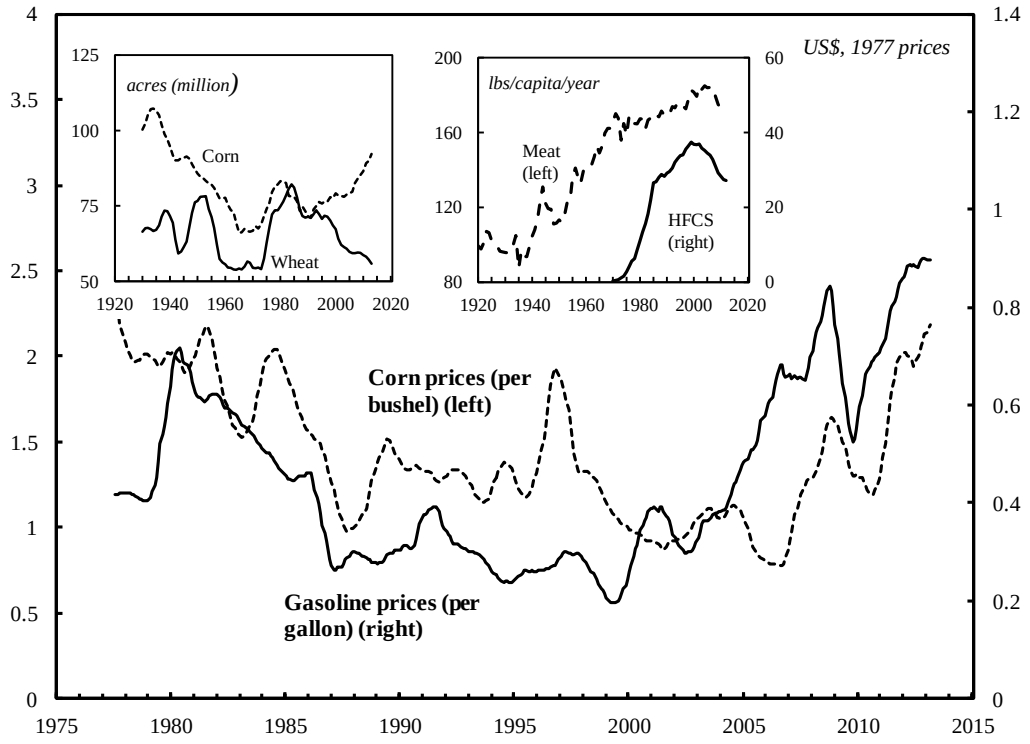

Figure 2: Transformations in the Political Economy of Corn

Note: Corn and gasoline prices presented as 1-year moving averages and deflated by the US chain-type price index. Acreage data presented as 5-year moving averages.

Source: 1977-2009 corn and gasoline prices from Commodity Research Bureau 2010 Yearbook. 2010-13 corn and gasoline prices from Index Mundi (2014). Corn and wheat planted acreage data from USDA ERS (2014a). US Producer Price Index from Global Financial Data; series code: WPUSAM. HFCS consumption data from USDA ERS (2014b). Meat consumption data from USDA ERS (2014c).

The soaring gasoline prices of the late 1970s conferred more credibility upon those who supported greater energy independence through the expanded use of US-produced alternatives to petroleum; and the general rise in corn production increased the feasibility of corn-ethanol being one of these alternatives. The grain

processing giant, ADM, seized the opportunity and relentlessly championed ethanol as a petroleum substitute. ADM at this point was the pre-eminent force in the durable food complex. It had long been the front-runner in developing myriad soy derivatives (Southwestern Miller Magazine 1972). Moreover, it dominated High Fructose Corn Syrup (HFCS) production, with its corn wet mills churning out one-third of the national output of the sweetener (ERS 1993, 22). However, ADM's HFCS operations were buffeted by seasonal cycles in consumption patterns. During the summer soft drink sales soar. But in the winter such beverages are not so popular. ADM figured that if the right government supports were in place, the very same corn mills that turned out HFCS to sweeten the huge quantities of Coke and Pepsi guzzled by thirsty American consumers in the summer months, could in the slow-selling winter months, produce ethanol to be guzzled by American automobiles. These seasonal switches of output in what ADM called its 'sweetener/alcohol complex' would ensure that the company's corn milling plants ran close to capacity, thereby boosting sales and minimizing production costs (Milling & Baking News 1982, 32).[6] It was within the womb of ADM's sweetener/alcohol complex that the broader food/fuel complex first developed.

ADM continuously flirted with scandal in its search for benefactors. According to a deposition given by a former presidential secretary, Dwayne Andreas – the then CEO of the company - personally delivered a package to President Nixon containing $100,000 in $100 bills in 1972. The cash was kept in a White House safe for around a year before being returned by Nixon when the Watergate scandal was beginning to engulf him (Carney 1995).[7] In another apparent attempt at currying favor, ADM bought Jimmy Carter's peanut warehouse for $1.2 million in 1981 (Weiss 1990). But ADM has not only bestowed its largesse upon the White House. It has also lavished Capitol Hill. Andreas's relationship to the self-described 'Senator of Ethanol' Robert Dole was particularly important. Dole frequently flew on ADM's private jets to speak at company engagements, and he received thousands of dollars in return. Additionally, Dole purchased Andreas's holiday home in Miami, below the market rate (Manning 2004). By cultivating close relationships with those in government, and by capitalizing on the broader shift in the climate of elite opinion that was brought about by soaring oil prices, ADM was able to reap bounteous rewards. Most notably, in the 1978 Energy Tax Act, a 40 cent tax exemption was granted to every gallon of ethanol mixed into gasoline and in the 1980 Omnibus Reconciliation Act, a 40 cent tariff was imposed on Brazilian ethanol.

[6] As ADM stated in its 1982 annual report, 'the benefits of the combined sweetener/alcohol complex continued to be apparent as ADM's plants were able to run at higher capacity levels year around than they would have without the alcohol option.' (as cited in Milling & Baking News, 1982).

[7] Moreover, in the wake of the scandal, in a sworn testimony made by Nixon's chief fundraiser, Kenneth Dahlberg, it was revealed that Andreas had given $25,000 to Dahlberg which was then passed onto one of the Watergate burglars as partial payment for the break-in of Democratic National Committee headquarters (Lieber 2000).

ADM also lobbied via the ostensibly farmer-based commodity groups that had superseded the farm bloc. For example, at the beginning of Reagan's presidency, ADM joined with the American Sugar Alliance to campaign for increased government support for sugar farmers. The campaign was a success. In 1981 a new Sugar Bill was introduced that extended import quotas on sugar and raised the price-floor of domestically produced sugar to about double the world market price. Soon after the bill was passed domestic sugar prices predictably increased and, in response, Coca Cola and Pepsi ratcheted up their orders of HFCS (Milling & Baking News 1984, 10). Partly as a result, American consumption of the sweetener surged (see right insert, Figure 2).[8] The import quotas on sugar also bolstered the corn-ethanol sector, for sugar was widely used as an ethanol feedstock in Brazil, and sugarcane ethanol was proven to have a far superior energy conversion ratio to corn-ethanol. The US ethanol sector was thus now doubly protected: from ethanol imports and from the imports of a rival feedstock. As ADM's sweetener/alcohol complex accounted for 87% of ethanol production capacity in the US and 32% of HFCS production capacity, it enjoyed the bulk of the benefits (Economic Research Service 1993, Henkoff 1990).

From a broad perspective then, the food regime approach is correct in arguing that the development of substitutable commodities, such as HFCS for cane sugar and ethanol-blended 'gasohol' for gasoline, can be considered as part of an overarching process through which capital overcomes barriers to accumulation in the agri-food system. But at the specific level of federal policy, the rise of the 'sweetener/alcohol complex' in the US can be seen as the result of an active restructuring of accumulation barriers. This restructuring created opportunities for ADM to increase its expected future earnings over and above other agri-food companies. The company not only jealously guarded itself from foreign competition through securing government tariffs and import quotas; it also barred potential rivals in the US from challenging its supremacy by pushing the ostensibly sector-wide lobby group - the Renewable Fuels Association (RFA) - to dissuade the US Department of Energy from disbursing loan guarantees to start-up ventures (Henkoff 1990). This strategy worked. By the late 1980s the company claimed a 75% share of ownership of total US ethanol processing capacity (Weiss 1990). Thus, the corn-ethanol sector remained little more than a government-backed monopoly. In maintaining its control over most of ethanol production and in maintaining its influence over the major lobbying organization for the ethanol sector, ADM was well positioned to engage in more policy breakthroughs in the 1990s. Once again bribes (viz. campaign contributions) appeared to be a key component of the company's success. In the 1992 US Presidential election race, ADM was the largest single source of funding for George Bush Senior's re-election bid and the third largest single source of campaign funding for Bill Clinton. In just one campaign fundraiser

[8] The biggest beneficiaries in agriculture were the 250 cane and beet growers that constituted the top one percent richest sugar farmers in the US. By 1991 this small group of farmers gained an astonishing 42% of the subsidies instituted by the Sugar Bill (General Accounting Office 1993, 4).

organized by Andreas, $3.5 million was raised for Clinton. Soon after Clinton was elected into office, he stipulated that 30% of fuel in America's nine most polluted cities be cut with ethanol, despite mounting evidence presented by his own advisors that the resulting gasohol fuel would lead to new environmental problems (Manning 2004, 27).

However, not everything was going to ADM's liking. As Figure 2 shows, during the 1990s the inflation-adjusted price of gasoline continued on a downward slope from the heights it reached at the beginning of the previous decade. As ethanol prices were in effect tied to movements in gasoline prices, and because gasoline prices were low, the profit margins of the company's ethanol operations were very thin (ADM 1994, 5). Moreover, the Asian Financial Crisis of 1997–8 greatly undermined ADM's export business. Up until that point East Asia represented a growing regional market for the company. But in the wake of the crisis, East Asian imports of the foodstuffs processed and transported by ADM fell dramatically. Dietary trends in the US compounded ADM's problems. The slowdown in per capita corn sweetener intake, as depicted in the right insert of Figure 2, was particularly worrisome for ADM because in the mid-1990s an estimated 40% of the company's profits were generated by its HFCS division (Kilman, Ingerson and Abramson 1995).

In this context, ADM re-evaluated its priorities. Up until the turn of the twenty-first century, ADM's ethanol operations were, despite all the government support, little more than an adjunct to its massive HFCS division. But this changed once per capita intake of HFCS began to taper off in the US. With widespread health concerns relating to HFCS and with ever more people switching from soft drink to bottled water consumption, ADM was clearly facing an uphill battle in pushing more corn syrup into American digestive space (Meyer 2005). It thus shifted its emphasis from increasing HFCS's 'stomach share' to increasing what I call ethanol's 'gas tank share'.[9] Meanwhile, medium-sized alternative energy ventures were slowly making inroads into ADM's preponderance in the ethanol sector. This was evidenced by the fact that by the late 1990s, the company's share of control over national ethanol production capacity fell to 46% (Heffernan 1999). Moreover, by the turn of the millennium powerful agricultural input firms and an increasingly assertive cadre of American corn farmers also began to find reason to put their weight behind the pro-ethanol agenda. As such, the corn-ethanol industry grew from being the almost exclusive plaything of ADM, into a sector that was courted by a burgeoning array of interests within US agribusiness and agriculture. It is to these interests that we now turn.

[9] This shift was emblematized by the appointment of Patricia Woertz – former Vice-President of the oil giant, Chevron – as the CEO of ADM in 2007.

ii) The emergence of the Agro-Trader nexus

Like ADM, many American corn farmers were weighed down by the price slump in global agricultural commodity markets in the late 1990s. In previous years, farmers could have relied on the US government to mitigate the price drops, through the combined use of land idling requirements and public grain reserves. However, the 1996 Farm Bill effectively discontinued all instruments of price stabilization. And in so doing, the bill completed the process of disbanding production controls commenced by the 1973 Farm Bill. Farmers now received direct payments, not on the basis of the difference between 'target prices' and 'market prices', but rather on their past acreage use. With payments now completely decoupled from prices and production, farmers had a strong interest in reversing the price decline of their crops. This interest was particularly acute for corn growers who saw the price of corn fall by 48% in the three years that followed the bill's implementation – the largest price drop of any of the major agricultural commodities (Winders 2009, Commodity Research Bureau 2010, Lehrer 2010). Corn growers thus sought to find new ways of increasing the consumption of their output. Supporting ethanol production appeared to be an elegant solution. Millions of bushels of corn could be channelled into this growing sector and farmers could enjoy additional income through directly owning the plants that processed corn into ethanol. As such, in the late 1990s, a large number of farmer-owned ethanol cooperatives were formed. These cooperatives tenaciously lobbied state and federal governments to establish tax incentives and targets for the use of ethanol as a fuel additive (Ray 2009, 2010).

The emergence of ethanol cooperatives was both a boon and a bane for ADM. On the one hand, the farmers' campaigns for more government support of ethanol production boosted ADM's attempts to augment ethanol's 'gas tank share'. On the other hand, farmer cooperatives posed a serious challenge to ADM's market share over the ethanol sector itself. The catalytic role of cooperatives in the ethanol boom is clearly indicated by the fact that by 2002 around 80% of the ethanol plants that were under construction were farmer-owned (Food & Water Watch 2011, 12). Moreover, by 2004 ADM's share of total operating capacity in the US had declined to 31%; meanwhile, the combined share attained by famer-owned cooperatives grew to 37% (Heffernan 1999, Hendrickson and Heffernan 2005). However, it was not just ADM and farmer-owned cooperatives that backed surging ethanol production. Three of the leading agribusiness input firms – Deere & Co., DuPont and Monsanto - also put their weight behind the agrofuel sector. And it is around the linkages between these agribusinesses and ADM that the Agro-Trader nexus took shape.

The nexus emerged at a time when control over ethanol production was slowly becoming more decentralized, while control over the agricultural input industry was becoming increasingly concentrated. This rapid rise in concentration emerged against the backdrop of landmark legislation, such as the 1994

Plant Variety Protection Act, that strengthened corporations' capacity to assert exclusive ownership over the building blocks of plant reproduction (Mascarenhas and Busch 2006). The chemical giant, Monsanto was particularly active in staking its claims. In 1998, during a period of just eight weeks, it bought up four major agro-biotech firms, including two of the top ten largest seed marketing companies in the world (Shattuck 2009, 90). And in 1999, DuPont - another chemical giant - bought up the firm that dominated the corn seed market: Pioneer Hi-Bred. Since this point, DuPont and Monsanto have enjoyed unsurpassed control over the reproduction of corn plant-life in the US. In terms of gene technology, Monsanto is a clear leader: by 2009 over 80% of the planted acres of corn in the US contained genetic traits owned by the company (Langreth and Herper 2009). And in terms of control over the distribution of the seed itself, by 2010 Monsanto commanded a 36% share of the corn seed market in the US while DuPont had a 34% share (Kaskey 2010).

Like ADM, these agro-biotechnology giants have extensive reach into the halls of US government. Perhaps the most important aspect of this influence comes in the form of the 'revolving door', whereby corporate employees of the past become corporate regulators of the present, and vice versa. Many agri-food corporations employ this strategy of peddling policy. But no company has been better at keeping the door between government and business revolving than Monsanto. Examples of company personnel moving in and out of government are legion. To take just a few cases: former Monsanto attorney, Clarence Thomas, is now a Supreme Court Judge; former Monsanto Vice-President for Public Policy, Michael R. Taylor, is currently Senior Advisor at the Food and Drug Administration; and former Monsanto and DuPont lobbyist, Islam A. Siddiqui, is the incumbent Chief Agricultural Negotiator for the US in international trade talks. Moving in the opposite direction: former Director of Agricultural Affairs at the Office of the US Trade Representative, Melissa Agustin, is now a lobbyist for Monsanto; and former Deputy Chief of Staff at the USDA, Jeremy Stump, is now Monsanto's Director of Government Relations (Boschma 2013, Center for Responsive Politics 2013). Keeping track of the many loyal purveyors of corporate power swinging in and out of public office may prove dizzying; but the point is that, through the revolving door, the seed giants are in effect regulating the very institutions that are meant to be regulating them. And as a consequence, their accumulation strategies are becoming progressively more synergized with the machinations of government (Baines 2014).

Monsanto and DuPont have used their considerable influence to push for the expansion of the ethanol sector for four main reasons. Firstly, corn is the primary input for ethanol feedstocks and, as has been noted, Monsanto and DuPont have unsurpassed control over the reproduction of the plant in the US. Secondly, because many of these corn varieties are bioengineered to withstand the application of broad-spectrum herbicides, such as Monsanto's RoundUp product, seed sales are also tied in with agrochemicals

sales for the major agro-biotechnology firms. Thirdly, of all the major commodity crops, corn requires the most chemically intensive production methods and this, in turn, further boosts Monsanto's and DuPont's revenues.[11] Finally, an expanding ethanol sector appeared to be expedient means of bolstering the consumption of GM corn in the context of the decline of HFCS intake discussed above, along with enduring consumer hostility towards transgenic foods.

Anti-biotech sentiment was particularly pronounced in European and East Asian markets. The international hostility towards GM food was a concern for the major seed companies because, for much of the 1990s, almost one-fifth of the corn produced in the US was exported (USDA ERS 2014e). However, annual corn exports from the US fell significantly after the first GM-corn crop was planted in the US in 1996. The loss of the South Korean corn market represented a notable blow to US corn interests, because it had been the world's second largest importer of US corn. Amid concerns regarding the health and environment implications of transgenic food, Korean importers rejected the GM corn grown in the US, in favor of non-GM corn from China. A similarly dramatic decline in the US's share in the EU soybean meal market in the early 2000s was also brought about by widespread consumer antipathy towards GM food. In the face of considerable pressure from European farmer and consumer groups, the EU imposed a de facto moratorium on regulatory approvals of transgenic crops. This moratorium existed in various forms throughout much of the 2000s. The introduction of biotechnology in US agriculture thus precipitated a reconfiguration of international trade flows that was unfavourable to US crop farmers and the major input firms that supplied them (Wisner 2004, Falkner 2009).

Within US agriculture, many wheat farmers have themselves been opposed to bioengineering, due to fears that the commercial rollout of GM wheat would have even more baleful repercussions in terms of the loss of export markets for their own crop. These concerns are well founded given the fact that wheat farmers are more dependent on exports than corn growers. Many wheat farmers believe that the inevitability of transgenic contamination of non-GM wheat crops, combined with the increased costs of segregating GM and non-GM wheat in distribution channels, would render their produce uncompetitive on international markets. In the major wheat growing states of Montana and North Dakota, farmers even pushed for a ban on the commercialization of transgenic wheat (Falkner 2009). This resistance culminated in 2009 when wheat farmer and consumers groups in the US authored a 'Definitive Global Rejection of GM Wheat' statement, with their counterparts in Canada and Australia. The statement excoriated Monsanto for

[11] Indeed, on average, farmers spend up to US$15 per acre more on pesticides for corn production than they spend on soybean production and almost US$40 per acre more on pesticides than what they spend for wheat production (Purdue Extension 2013). And as soaring ethanol production encourages the abandonment of crop rotation in favor of growing corn on the same land year after year, the chances of pest infestation are heightened; and this, in turn, increases farmer dependency on the 'biophysical overrides' provided by the agri-biotech giants (Weis 2010).

seeking to bring GM wheat from its testing fields into commercial markets (Bloomberg 2010). The persistent and widespread anti-biotech sentiment in key export markets, and resistance among wheat farmers to transgenic crops within the US, underscored the appeal of the ethanol sector for the seed giants. These companies' commitment to ethanol was revealed at the beginning of the agrofuel boom. In the early 2000s, DuPont developed a hybrid seed screening initiative to determine which strains of corn will yield the most ethanol per acre (Butzan and Haefele 2008). Similarly, Monsanto launched a 'Fuel your Profits' seed program geared to breeding corn that could be more easily fermented into ethanol (Monsanto 2003).

The agricultural machinery firm, Deere & Co., has also actively promoted the development of the ethanol sector. This support is in part due to the fact that soaring corn-ethanol production bolsters corn prices, which in turn increases the cash flow of the company's main customers: commercial crop farmers. Indeed, Deere's machinery is expensive - average-sized combine harvesters sold by Deere cost around US$400,000, while a John Deere row-planter is priced up to US$300,000 - so farmers understandably prefer to have a strong income stream when they buy such items. Moreover, the absorption of masses of corn into the ethanol sector brings more land into agricultural production. Thus, Deere wagered that the ethanol boom would likely stimulate the increased purchase of specialized farm vehicles and equipment (Tepe *et al.* 2011). And as the company commands a 46% market share over the agricultural machinery sector in the US, it would be the major beneficiary (UOIG 2012, 7). Deere clearly expressed its support for ethanol in 2007, by backing the '25 by '25' resolution put forward by a group of Congressman to establish a national target of producing 25% of the US's energy from 'renewable sources' - such as solar, wind and agrofuels - by 2025. One year later, Deere further underlined its commitment to the agrofuel boom by joining ADM, DuPont, Monsanto and the RFA to create the 'Alliance for Abundant Food and Energy' – a lobbying group that advocates continued government support for ethanol and biodiesel. With the formation of this alliance, the Agro-Trader nexus had crystallized into a distinct institutional form (Borgman 2007, Cameron 2008). As the left side of the network diagram in Figure 3 shows, the Agro-Trader nexus encompasses many organizations, from groups representing corn farmers (the National Corn Growers Association), to railroad interests (the Union Pacific Railroad), to oilseed processors (Bunge). However, the main axis of power within this constellation of social forces is constituted by the four founding firms of the 'Alliance for Abundant Food and Energy', shaded in grey: ADM, Deere & Co., DuPont and Monsanto. Interestingly, in 2009 these four firms also founded the 'Global Harvest Initiative' - an ostensibly anti-hunger campaign group that pushes for GM crop production and expanded agrofuel development throughout the world (Holt-Giménez and Shattuck 2011).

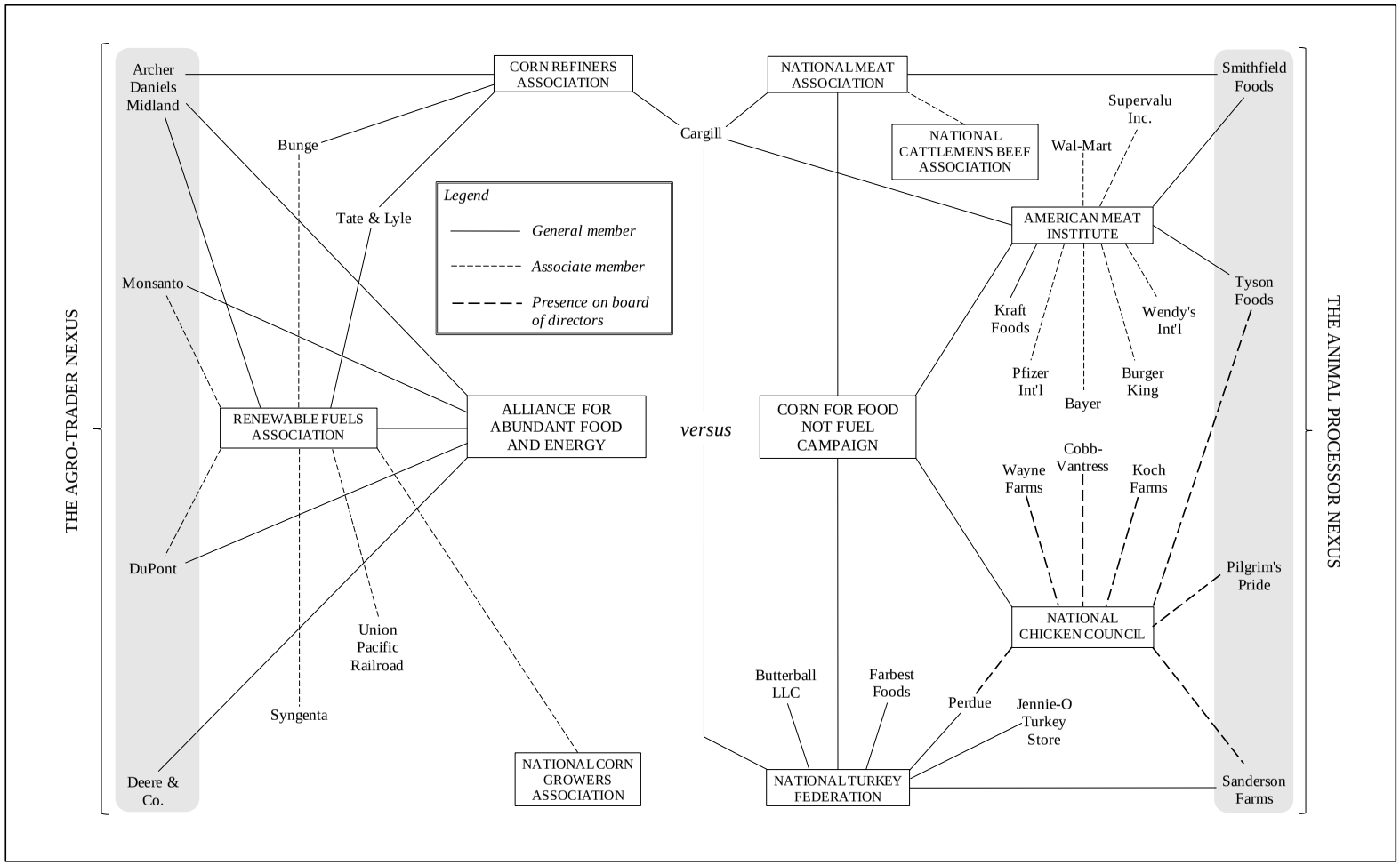

Figure 3: Two Axes of Power in the Corporate Food Regime

Note: National Chicken Council membership data appears to be unobtainable. As such, the figure presents data on the presence of corporate personnel on its board of directors instead.

Source: Membership data for the Alliance for Abundant Food and Energy; Renewable Fuels Association; Corn for Food not Fuel campaign; National Meat Association; American Meat Institute and the National Turkey Federation from: Cameron (2008); RFA (2014); CFNF (2014); NAMA (2014); AMI (2014) and NTF (2014). Directorship data for National Chicken Council from NCC (2010).

iii) The Agro-Trader nexus versus the Animal Processor nexus

The corporate appropriation of various aspects of commodity crop production has been mirrored by the corporate appropriation of the phases through which animal life is converted into consumer meat products. The increased concentration of control over the livestock-feed complex is partly indicated by the fact that the market share of the four largest firms in the US meat packing sector rose from a post-war low of 19% in 1977 to 59% just 25 years later (US Census Bureau 2013). Table 1 relays the latest obtainable data on meat company shares over animal kill in the US and it also puts the slaughtering of American domesticates within a global context. Although startling, the figures presented in the table do not tell us anything about the amount of control that major meat companies wield over animals prior to their death and dismemberment. In fact, some of the companies listed in the table have incorporated the very reproduction of animal life within the domain of their business. In a process that mimics the development of hybrid crops, these meat companies have engaged in the crossing of different pure-bred lines of animals so as to optimize certain genetic traits that conduce to greater and more predictable earnings. As the offspring of hybrids do not reproduce the same traits found in animals conceived from the initial crossing of 'nucleus herds', farmers return to the cross-breeders to replenish their stock of animals (Fuglie *et al.* 2011). Thus, cross-breeding extends companies' exclusionary control over the meat production process and it simultaneously re-shapes animal life in ways that are propitious for future pecuniary gain.

The growing corporate control over the lives and deaths of American domesticates has been particularly pronounced in the poultry sector. The largest poultry firm, Tyson, now commands a 60% market share of the US chicken breeding stock (Food Safety Magazine 2007). In a system of vertically integrated operations that was first developed in the 1950s, contract farmers receive feed from Tyson along with one day old chicks delivered straight from Tyson's own hatcheries. The chicks are housed in factory-like structures made according to Tyson's specifications and after a period of 7-9 weeks they are taken to Tyson's slaughterhouses (Boyd and Watts 1997). Smithfield spearheaded the adaptation of this model of vertical integration to the swine business in the 1990s. The company began to control every stage of hog production: from the DNA lines, to the 'farrowing' of pigs, to the 'finishing', to their eventual slaughtering and processing into consumer products (CGGC 2009). Corporate power over cattle breeding is not so centralized, due in large part to uncontrolled mating in the rangeland and pasture conditions of the early stages of steer-raising (Fuglie *et al.* 2011). However, in the last stages of steer-raising, in which the cattle are confined to feedlots, ownership is highly concentrated. In fact, some feedlot operations are so vast that they can accommodate over 100,000 cattle at a time (Millet 2006, 223).

	Number Slaughtered in the world annually	Number Slaughtered in the US annually	4 Largest Firms in the US	Share of US Animal Slaughter (%)
Chickens	59.9 billion	8.7 billion	1. Tyson Foods	21
			2. Pilgrim's Pride	18
			3. Sanderson Farms	7
			4. Perdue Farms	7
Turkeys	649.5 million	250.1 million	1. Butterball	19
			2. Jennie-O Turkey Store	18
			3. Cargill VA Meats	15
			4. Farbest Foods, Inc.	6
Pigs	1.4 billion	107.5 million	1. Smithfield Foods	26
			2. Tyson Foods	17
			3. JBS Swift	11
			4. Cargill	9
Cattle	295.5 million	31.9 million	1. Tyson Foods	23
			2. JBS USA	21
			3. Cargill	20
			4. National Beef Packing	11

Table 1: Animal Slaughter and Corporate Control

Note: Global and US slaughter figures as of 2012. Market share data for chicken slaughter as of 2014. Market share data for turkey, cattle and pig slaughter as of 2013.

Source: Global and US animal slaughter figures from FAOSTAT 2014. Market share data for chickens, turkeys, pigs and cattle presented in Watt Poultry 2014, Pork Checkoff 2013 and Cattle Buyers Weekly 2013 respectively.

The functional division of animal husbandry from crop agriculture has coincided with the emergence of regions of specialized crop production and regions of specialized meat production. This spatial separation was also spurred by the low agricultural commodity and energy costs that prevailed for much of the 1980s and 1990s, as outputs from crop monocultures could be cheaply processed and transported into inputs for intensive animal-meat production. In this context, the American Midwest, within which the Corn Belt is situated, transformed from being the main integrated crop-and-livestock farming region in the US to the heartland of specialized corn and soybean production. Meanwhile, commercial beef production has slowly shifted westward and southward to the huge feeding operations in the Southern Plains. Contrariwise, the national center of hog production has gradually migrated east of the Corn Belt in large part because of the opening of enormous factory farms in North Carolina. Moreover, poultry production has transformed from being a dispersed, rural household activity to an industrialized process centered in the Southern states of Georgia, Arkansas and Alabama (Boyd and Watts 1997, Hart and Mayda 1998).

Hence, by the turn of the millennium, agribusiness control over agriculture was simultaneously highly consolidated and bifurcated. A small group of oligopolistic firms superintended the production and processing of commodity crops and a small group of oligopolistic firms commandeered the conversion of animals into meat products. As corn growers increasingly became reduced to being providers of feed inputs for the livestock-feed complex, fewer and fewer raised their own livestock. It was in the context of this diminution of integrated livestock-crop farming that corn farmers considered investment in ethanol cooperatives as their best alternative source of 'value-added' (Ray 2009). Moreover, by promoting and facilitating the diversion of grain from the feed sector the Agro-Trader nexus appeared to have wagered that it would be able to gain leverage over the major meat companies. But while the earnings strategies of corn farmers and the Agro-Trader nexus played an instrumental role in the ethanol boom, the rapid development of the ethanol sector in the 2000s was also intertwined with wider transformations in global capitalism. In particular, the 'War on Terror' contributed to the reignition of instability in the Middle East and due to the ensuing panic in global energy markets, oil prices began to surge (Nitzan and Bichler 2006). Just like the oil price spike of the late 1970s, oil price rises in the early twenty-first century had a sharp knock-on effect on gasoline prices (see Figure 2). This knock-on effect imparted a veneer of credibility to the emergent Agro-Trader nexus's claims that the ethanol sector could bolster US energy security. It was in this context that the 2005 Renewable Fuel Standard (RFS) was implemented. The RFS mandated the blending of 7.5 billion gallons of agrofuel into America's gasoline supply by 2012. In 2007 the food/fuel complex was further bolstered by the US Energy Independence and Security Act. This piece of legislation increased the RFS to 15 billion gallons of corn-ethanol by 2015 and endorsed the '25 by '25' vision backed by Deere (Shea 2007).

The enactment of the ethanol mandates caused massive interstitial restructuring between the overlapping food/fuel and livestock-feed complexes. As Figure 4 shows, the ethanol sector's share of total corn produced in the US rose from just 6% in 2000 to over 40% in 2012. Meanwhile, the share of corn used by the livestock-feed complex plunged. The turning point appears to have been 2005, when the ethanol mandate was first introduced. Until that year, increases in corn-ethanol production did not lead to a substantial decline in the share of corn consumed by the feed grain sector. However, at the height of the ethanol boom, from 2005 to 2012, the share of total corn produced in the US for feed fell from 58% to 36%. Given that 90% of feed grain used in the animal processing sector is corn-based; and given that feed comprises 60-70% of livestock production costs, the diversion of corn into ethanol distilleries had a huge impact on the meat business (Becker 2008). The effect is confirmed by the insert of Figure 4. As the graph shows, the falling share of corn used for meat production from 2005 onwards has coincided with a structural shift in feed grain prices relative to meat prices. Moreover, the structural shift appears to be particularly stark in the hog and poultry sectors. From 1985 to 2005 a pound of pig meat cost around

twenty times more than a pound of corn and a pound of chicken meat cost around five times more than a pound of chicken feed. But by 2012, a pound of pig meat cost just ten times more than a pound of corn and a pound of chicken meat was just three times more expensive than a pound of chicken feed. Although feed-meat price ratios within the beef sector have historically been more cyclical than the poultry and hog sectors, a sharp fall in the steer and heifer to corn price ratio can also be seen from 2005 to 2012. The precipitous drops in the meat price-feed price ratios during these seven years were driven by soaring corn prices. Indeed, in this period, inflation-adjusted corn prices increased by 215%, while inflation-adjusted average meat prices increased by merely 7%.[13]

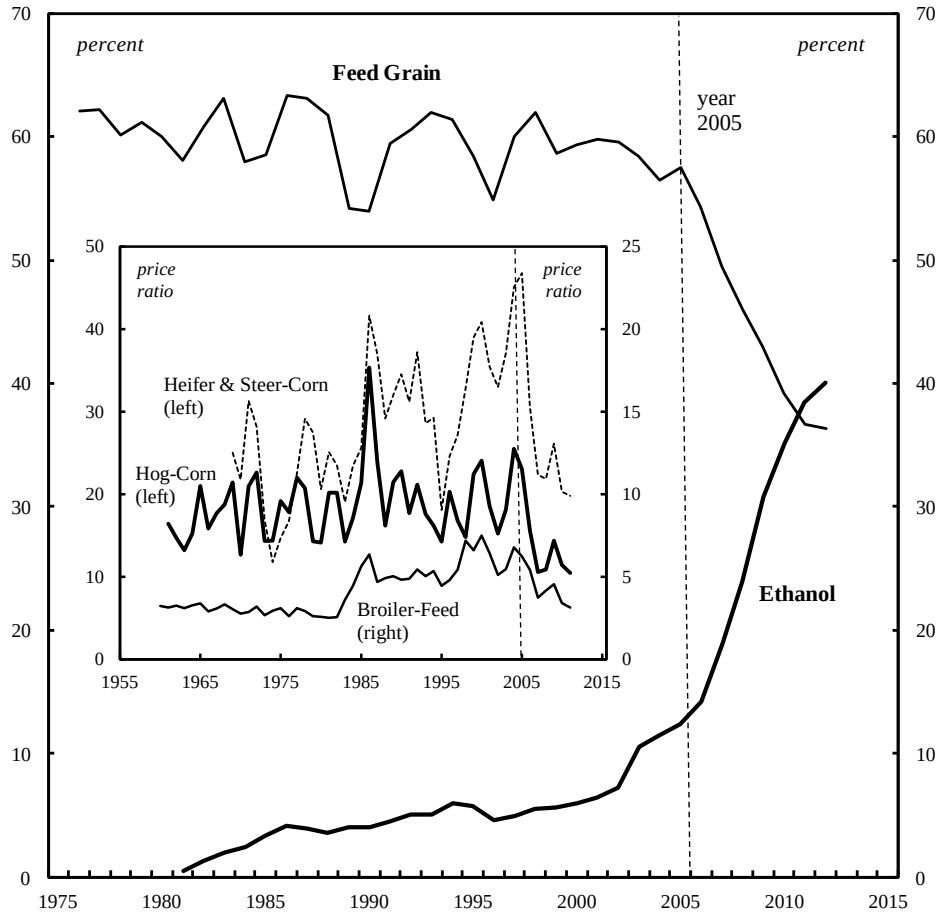

Figure 4: Proportion of Domestically Produced Corn used by Feed Grain and Ethanol Sectors

Note: The feed price – meat price ratios weigh the price of feed per pound against the per pound price of meat.

Source: Feed price – meat price ratios from USDA ERS (2014a). Corn use data from USDA ERS (2014d).

[13] Author's own calculations. Meat prices and corn prices deflated by CPI. Series codes: M111CPALTT01XOA.M; WPIP0221.M; and WPI01220205NS.M for CPI, meat prices and corn prices respectively. Data from Bureau of Labor Statistics, through Global Insight.

The inflationary impact that the ethanol sector has had on feed prices underscores the severe tensions within the corporate food regime, between the food/fuel complex, on the one hand, and the livestock-feed complex, on the other. To be sure, when the ethanol sector was a peripheral feature of the agrarian political economy of the US, there was very little opposition within agriculture and agribusiness to the use of corn as a fuel feedstock. However, once ethanol production shifted from being an ancillary income support for a small set of farmers and corporations to an overt attempt at restructuring prices and redistributing income within agriculture and agribusiness as a whole, disunity broke out. Fault lines first became visible in the early 2000s when US ethanol production started to take-off. And these fissures enlarged into wholesale rupture by 2005 when the RFS was instituted. As Figure 4 shows, it was in that year that the relative price shifts began to have a jolting impact on animal agriculture in the US.

The dramatic price shifts coincided with sharply contrasting pronouncements made in regard to the effects of the ethanol sector on the meat business. Indeed, in 2006, the then CEO of ADM, G. Allen Andreas, bluntly stated: '[t]here is no consumption versus combustion debate, except for those who really do not recognize the realities of the way this business functions' (Milling & Baking News 2006, 11). The CEO of Tyson Foods, Dick Bond, did not recognize the 'realities' that his counterpart at ADM was referring to. In fact, Bond could hardly contain himself when remonstrating against the ethanol sector: 'I can rant and rave about this for some time, but some of the things that our government in Washington has done in terms of mandating the use of corn-based ethanol… it's not right' (Mosely 2008). Similarly, in an op-ed for the Wall Street Journal, Larry Pope - the CEO of Smithfield – argued that the US government's mandate on ethanol blending had a more grievous effect in terms of increasing corn prices in 2012 than the deleterious drought of that year. '[I]f the ethanol mandate did not exist', Pope moaned, 'even this year's drought-depleted corn crop would have been more than enough to meet the requirements for livestock feed and food production at decent prices' (2012). Such is their animus toward the RFS, interest groups within the US livestock sector have even set up a 'Corn for Food not Fuel' campaign group , to encourage concerned consumers to join them in their movement against corn-ethanol.[14]

As Figure 3 indicates, the Corn for Food not Fuel campaign is headed by four major meat business lobbying groups: the American Meat Institute, the National Meat Association, the National Chicken

[14] Cargill holds an ambiguous position in regard to the 'feed versus fuel' debate. On the one hand, it has played a significant role in supporting the ethanol sector, not only through developing hybrid corn and bioengineered corn for ethanol production, but also by opening up its own ethanol plants. Indeed, at the turn of the twenty-first century it had the fifth largest share of control over the sector (Heffernan 1999). On the other hand, Cargill's more substantial interests in consumer food and animal feed markets have made the company reluctant to lend its full backing to ethanol production. This reluctance was evidenced in a statement by Cargill's CEO, Warren Staley, in which he advocated 'a hierarchy of value for agricultural land use: food first, then feed and last fuel' (cited in Milling & Baking News 2006, 11). By straddling the Agro-Trader nexus and the Animal Processor nexus and by adopting a comparatively equanimous position in the 'feed versus fuel debate', Cargill is the exception that proves the rule.

Council and the National Turkey Federation. It is around this network of lobbying groups that a new corporate-led distributional coalition - the Animal Processor nexus - can be seen to take shape. Whereas the Agro-Trader nexus encompasses a fairly narrow set of groups that operate upstream in agricultural supply chains such as seed firms, crop growers and trading firms; the Animal Processor nexus is part of a broader and more diffuse constellation of interests that operate further downstream in supply chains. This constellation of interests begins with livestock farmers that use basic crop derivatives, such as corn meal as inputs to raise animals into edible commodities. And it ends with those multinational firms, such as Burger King and Wal-Mart, that sell processed and reconstituted forms of animal-based, as well as plant-based, commodities to consumers. Pharmaceutical companies such as Pfizer and Bayer (see Figure 3) are crucial in this supply chain as they furnish livestock growers with the antibiotics that increase animals' biophysical capacities to withstand extreme crowding and confinement (Weis 2013). But the axial firms in the Animal Processor nexus are the major meat packing companies: Tyson Foods, Smithfield Foods, Pilgrim's Pride and Sanderson Farms. Their dominance in the livestock-feed complex is attested to by their shares in overall animal slaughter (see Table 1), and it is also affirmed by the fact that they are the four largest meat packers headquartered in the US by market capitalization.

The charges and counter-charges between key figures in the US agri-food sector clearly point to polarized opinions amongst the agribusiness elite. And the emergence of the Alliance for Abundant Food and Energy and the Corn for Food not Fuel campaign is also indicative of a deepening cleavage within US agri-food capital. But what connections, if any, can we draw between these recriminations and alliances, on the one hand, and the changing pecuniary quantities of prices and market capitalization, on the other? Figure 5 presents the contrasting power trajectories of the axial firms of the Agro-Trader nexus and the axial firms of the Animal Processor nexus. The average per firm market capitalization of each corporate grouping is divided by the average per firm market capitalization of dominant capital for every quarter to yield differential capitalization data. Dominant capital is represented in this analysis by the top 500 corporations listed in the US, ranked by market value for each quarter. The right insert presents the Agro-Trader nexus's and Animal Processor nexus's differential markup. This is calculated by dividing the net income to sales ratios of each corporate grouping by the weighted average of the net income to sales ratio of dominant capital. Thus, while the main chart in the figure depicts changes in investors' collective appraisal of the power of the Agro-Trader nexus and Animal Processor nexus, the right insert depicts changes in the relative capacities of both corporate constellations to turn a profit. The left insert switches the focus from the redistribution of power and profitability within agribusiness to the redistribution of income within agriculture. The differential income of corn growers and livestock farmers is calculated by dividing their respective average net incomes each year by the corresponding net income of all farmers in

the US. The average net income data of livestock farmers is the weighted average of the net income of cattle farmers, hog farmers and poultry farmers.

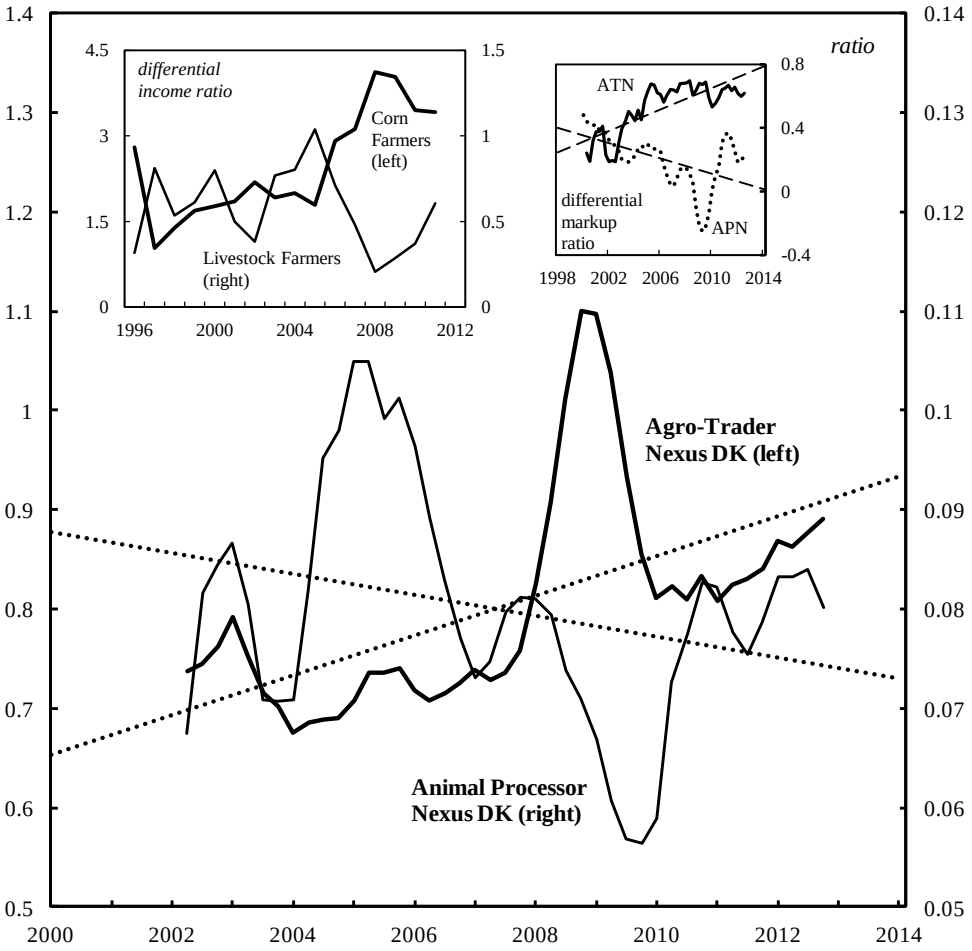

Figure 5: The Differential Capitalization (DK) of the Agro-Trader nexus and the Animal Processor nexus

Note: The differential capitalization and differential markup of the Agro-Trader nexus and Animal Processor nexus is presented as one-year moving averages. 'Livestock farmers' is a composite category comprising cattle, hog and poultry farmers, weighted by farm population size. Given DuPont's wide ranging activities, only its agricultural division's net income and revenue data were included in the calculation of the Agro-Trader nexus's differential markup.

Source: Company market capitalization from Compustat through WRDS. Archer Daniels Midland, Deere & Co. and Monsanto net income and revenue data from Compustat through WRDS. DuPont's agricultural division net income and revenue data from 10-K SEC filings. Farmer net income data from the USDA NASS (2013).

Three major observations can be made from the figure. Firstly, the market capitalization of the Agro-Trader nexus is greater than that of the Animal Processor nexus by an order of magnitude of around ten. Secondly, as the trendlines suggest, while the Agro-Trader nexus has accumulated power ever since the

onset of the ethanol boom, the Animal Processor nexus has experienced a general decline in power. Thirdly, in addition to these general trends, there are interesting oscillations in the differential capitalization of both the Agro-Trader nexus and the Animal Processor nexus. The Animal Processor nexus experienced a significant upsurge in its power in 2004 and 2005, when meat consumption and meat price-feed price ratios reached high-points (see Figure 2 and Figure 4). However, from 2006 to 2010 – when ethanol production soars and when meat price-feed price ratios plummet - the Animal Processor nexus's differential capitalization dropped almost uninterruptedly. And when the Agro-Trader nexus reached the zenith of its power in 2009, the differential capitalization of the Animal Processor nexus was well on its way to reaching a nadir.

Similar patterns can be seen in the differential income data of corn growers and livestock farmers. In terms of magnitudes, from 1996 onwards corn farmers have enjoyed incomes that are on average almost six times larger than their counterparts in animal agriculture; and in terms of the changes in these magnitudes, the shifts in the differential incomes of corn farmers and livestock farmers are broadly synchronized with the power trajectories of the Agro-Trader nexus and the Animal Processor nexus respectively. The differential incomes of livestock farmers reached a peak around 2005 just like the differential capitalization of the Animal Processor nexus; and like the capitalized profit shares of the Animal Processor nexus, the livestock farmers' income share bottomed out in 2008 only to increase again from 2009 onwards. Moreover, similar to the Animal Processor nexus, the livestock farmers experienced a general decline in relative pecuniary earnings in the period covered by the data. Contrariwise, the differential income of corn growers has trended upward since the beginning of the twenty-first century, just like the differential capitalization of the Agro-Trader nexus. Additionally, the corn growers' relative earnings reached an apogee in 2008-9 – the very same time that the power of the Agro-Trader nexus climaxed.

The general synchronicity between the relative pecuniary earnings of the Agro-Trader nexus and the corn growers on the one hand, and the Animal Processor nexus and the livestock farmers on the other, suggests that the redistribution of power within agribusiness is tightly connected to the redistribution of income within agriculture. This insight is important because extant food regime accounts of agrofuels tend to examine the power dynamics *between* agri-food capital and agricultural producers. In contradistinction, the analysis offered here cuts *across* the agribusiness/agriculture divide to show how one cluster of farmers and agri-food corporations appears to be benefiting at the expense of another.[15] Therefore, to use

[15] In his account of the effects of the ethanol boom on rural communities in northeastern Iowa, Sean Gillon (2010) adds texture to discussions about the power processes behind agrofuels. More specifically, he points to the uneven impacts of soaring agrofuel production within agriculture, by stating that livestock farmers have been more brazenly opposed to the corn-ethanol boom than corn farmers. But he maintains that even in the corn growing sector, 'farmers

the words of White and Dasgupta cited in the introduction of this paper, we can make more incisive claims about 'the structures of accumulation or (dis)accumulation' and the 'accompanying processes of social differentiation' in the agrarian political economy of the US. In terms of the structures of accumulation and (dis)accumulation, the Agro-Trader nexus has been accumulating rapidly for much of the early twenty-first century, while the Animal Processor nexus has been generally dis-accumulating. And in terms of social differentiation, the divergent pecuniary trajectories outlined here point to the opening of a significant cleavage between corn growers, on the one side, and livestock farmers, on the other.

The divergence in power between the two corporate-led distributional coalitions was starkest in 2008 and 2009. During this period, ADM capitalized on, and contributed to, the interstitial shifts between the interconnecting food/fuel and livestock-fuel complexes. In the context of generous government support for agrofuels, it could direct vast quantities of corn into the burgeoning ethanol sector over which it had preponderance. In fact, ADM's ethanol division was the largest contributor to company earnings in 2007 - accounting for 19% of profits (Weber 2008). Additionally, ADM was able to benefit indirectly from the ethanol boom because of its control over the 'tollgate' that divided agricultural commodity processing from feed production. The company's heightened capacity to re-channel corn into the ethanol sector allowed it to exact more favorable prices for the feed inputs it renders to the Animal Processor nexus. The Agro-Trader nexus also benefited from its control of key tollgates further upstream in food supply chains. Indeed, Monsanto and DuPont have used their combined 70% market share over the corn seed market and their unsurpassed control over plant genetics to capitalize on the ethanol surge. More and more land that used to be committed to wheat production has been turned over to corn production (see right insert of Figure 2). And as GM corn acreage has eaten into non-GM wheat acreage, farmers have increasingly drawn upon inputs, such as Roundup herbicide and RoundUp Ready corn, sold by the seed giants. Deere & Co. also appeared to benefit from the corn price boom. Farmers were newly flush with cash and were thus more willing to purchase Deere's highly expensive specialized machinery and equipment (Blumenthal 2012). The enhanced relative profitability of the Agro-Trader nexus's operations is registered in the steady rise in its differential markup during the agrofuel boom, as presented in the right insert of Figure 5.

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failed to reap large profits' (2010, 732-3). Although these insights regarding corn farmer profits may apply well to the rural communities he investigated, the data presented in Figure 4 suggest that they are not applicable to corn growers in the US as a whole. As such, the methods and concepts deployed in my mid-range analysis of redistributional conflict may not only add specificity to the macroscopic explorations of McMichael, they perhaps also help contextualize the findings arrived at in the fine-grained, field research offered by Gillon. Another important case-study, authored by Bain and Selfa (2013), offers insights that corroborate some of the findings in this paper regarding corn farmers' support of the corn-ethanol boom.

However, there is perhaps a danger of overdrawing the differences in the experiences of the agrofuel boom for those farmers and agribusinesses involved in animal agriculture and crop agriculture. In fact, agrofuel apologists are keen to point out that the corn used by the ethanol sector is not entirely diverted from the livestock-feed complex as an animal feed called dried distillers' grains (DDGs) is an important bi-product of the ethanol production process. Nonetheless, a good deal of skepticism is felt in regard to its value as an input in animal agriculture. This skepticism is in part born out of the fact that the price of DDGs moves in tandem with the price of corn and when the inferior energy and nutritional content of distillers' grains are factored into calculations of its price, it does not appear to be much cheaper than corn feed itself (Welch 2011). Opposition to the use of the ethanol bi-product is most trenchant in the poultry sector. Indeed, chicken farmers usually limit DDGs to 5% of the overall feed ration because of the limited capacity of birds to digest the input. As the President of the National Chicken Council, demurred:

> '[T]his lesser feed is not coming at the discount that corn farmers and the ethanol industry would have you believe. Though DDGs provide a 25 percent "savings" compared to corn feed, that discount is nullified when considering the 275 percent spike in overall corn prices brought on by the RFS. Think of it as a grocery store raising prices by a couple of dollars then trying to win you over with a 50-cent coupon.' (Brown 2013)

These arguments push us to supplement the contention put forward by Goodman *et al.* (1987), and then later developed by Friedmann and McMichael (1989), that the substitution of perishable foods into durable and interchangeable commodities has increased the power of agri-food capital over the agricultural process. This claim is certainly true at a broad level of analysis. By breaking heterogeneous agricultural goods into their relatively generic constituent parts (*e.g.* starch, fibre, oil, protein), agri-food capitals can, in principal, switch their use of agricultural commodities as market conditions dictate. However, not all commodities are valorized equally in the corporate food regime. Corn contains the most metabolizable and digestible energy of any of the cereal crops, and is thus the most prized feed grain in US agriculture. As I have already indicated, corn's status as the premier source of energy in the livestock-feed complex is indicated by the fact that it accounts for 90% of the grains consumed by livestock in the US. Given that chickens, and even pigs, have a limited ability to feed on other commercial sources of energy such as DDGs, poultry and hog operations are left particularly exposed to upswings in corn prices. This exposure is evidenced by the fact that during the two years from 2006 to 2006 when the cost of feed increased by two-thirds, and corresponding live-production costs increased by 80%, the portion of corn in chickens' overall diets held constant (NCC 2013). The process of substitution is, in this sense, inherently differential. The dramatic increase in the substitution of corn-ethanol for petroleum in the fuel sector

completely overwhelmed farmers' rather limited capacity to substitute corn feed for comparable sources of energy in the livestock-feed sector.

Notwithstanding this observation, in the cattle sector there is less criticism of DDGs. In fact, as ruminants are much moreable to digest distillers' grain, it can comprise up to 50% of cattle feed formula. And overall the cattle sector is estimated to account for 75% of total domestic consumption of DDGs (Fatka 2011). Interestingly, however, the mitigating effects of DDGs on the inflationary impact that the ethanol boom has had on feed prices have been most pronounced for the livestock farmers that remain in the Corn Belt. Indeed, as approximately 85% of ethanol production capacity is concentrated in the Midwest, farmers in the Corn Belt can access DDGs at a lower cost than those farmers in other parts of the US. The differential expense advantage that they enjoy derives from the fact that, in this current period of relatively high energy prices (see Figure 2), it is costly to transport DDGs. Moreover, due to the 15% moisture content of DDGs, there are concerns that the ethanol bi-product will spoil if it travels long-distances. These expiration issues are even more pronounced for the cheaper ethanol bi-product, feed substitute: wet distillers' grains. Thus, given the generally high transportation costs and given the spoilage concerns, most distillers' grains are used by farms that are situated within a 100km radius of the ethanol plant from which the bi-product has been churned out (Gottschalk 2007).

These insights regarding the uneven effects of distillers' grains suggest that the ethanol boom in the US has not only redistributed income from the livestock sector to the corn sector; in fact, it may have also redistributed income *within* the livestock sector, from farmers outside of the Corn Belt, to those inside it. But the regional shift is only in part born out of the differential cost advantage that distillers' grains afford Midwestern farmers. It is also due to increased regional price differentials in corn itself. Indeed, at the height of the spike in corn price inflation in late 2008, corn prices in the central Corn Belt state of Iowa were 13% lower than corn prices in North Carolina – the American heartland of industrialized pork production; and Iowan corn prices were 7% lower than the corn prices in Texas – the US's number one beef producing state (Queck 2008, 28). The significant price differential largely derived from the general uptrend in energy costs in the 2000s (see Figure 2). As with DDGs, corn became more expensive to transport. Moreover, livestock farmers in the Corn Belt had one final advantage over livestock farmers elsewhere: land that they had previously rented out to specialized corn growers could be taken back into their own integrated crop-livestock production operations. As such, they could cover all of their feed grain input needs with corn raised on their own land. This 'internal hedge' has buffered these farmers from the high and volatile corn prices that have prevailed in recent years (Fatka 2011). Thus, just as low feed input prices and energy costs in much of the late twentieth century conduced to the increased functional division and regional separation of crop and animal agriculture, the more recent increases in feed input

prices and energy costs may have contributed to a modest re-integration of livestock and crop production in the Midwest at the beginning of the twenty-first century. As a consequence of this modest re-integration, livestock production in the Midwestern states appears to be resurging, at least in relative terms. To illustrate, from 2005 to 2012, cattle inventories in Texas, decreased by 13.7%; while cattle inventories in the central Corn Belt state of Iowa increased by 8.3%; similarly, in the same period, Iowa's pig population increased by 20.8% while the corresponding pig population in North Carolina – the heartland of factory farmed pig operations – has fallen by 11.3% (USDA NASS 2014). Given these considerations, it seems apparent that the corn-ethanol boom has not just engendered redistributional restructuring between different axes of corporate power, and between different sectors within US agriculture. In fact, the agrofuel boom has driven redistributional shifts across different regions within rural America. The geographically uneven outcomes of soaring corn-ethanol production are vividly confirmed in Figure 6. This chart compares the relative incomes of farmers in the Corn Belt to the relative incomes of farmers in the Southern Seaboard. The Southern Seaboard is important to this analysis because it includes not only the number one beef producing state (Texas) and the number one state for industrialized hog production (North Carolina), but also the three largest poultry producing states (Arkansas, Alabama and Georgia). As the chart shows, when the corn-ethanol boom started to take off in 2005, the average relative income of farmers in the Southern Seaboard slid precipitously. In contradistinction, the average relative income of farmers in the Corn Belt began to climb steeply after 2002. And while the relative earnings of Southern Seaboard farmers have recovered since 2010, the relative earnings of Corn Belt farmers have continued to ascend to new peaks.

The great divergence within agriculture between farmers inside the Corn Belt and farmers outside the Corn Belt, and the coeval schism between the Agro-Trader nexus and the Animal Processor nexus, has been mirrored by a growing divide on Capitol Hill. In the mid-2000s when national gasoline consumption was still on the increase and when the US army was still deeply engaged in its Iraq adventure, politicians representing Corn Belt states enjoyed a broad-base of congressional support for their initiatives to bolster the ethanol sector. Considerations of 'energy security' reigned supreme. However, from 2007 onwards national gasoline consumption declined due to improved automobile efficiency and a decline in travelling by recession-hit drivers. Moreover, the widespread introduction of hydraulic fracturing ('fracking') has opened vast shale fields for oil extraction. As a result of these developments, ethanol increasingly appears to be the panacea of yesteryear. Members of Congress representing Corn Belt states still staunchly promote US government support for ethanol, as their interests are intertwined with the agribusiness-agricultural constituencies that they represent. Nonetheless, they have found themselves fending off an anti-corn-ethanol drive headed by political representatives of major meat producing states such as Arkansas, Alabama, Georgia and Tex. In fact, the governors of 8 of the 11 Southern Seaboard States

pushed for a waiver of the RFS (Winters 2012). The waiver applications were denied by the Environmental Protection Agency. But the major meat producing states have enjoyed legislative breakthroughs in other areas. Most notably, in 2012, the US Congress voted to discontinue two bulwarks of the ethanol sector that had existed for over three decades: tariffs on imported ethanol and the tax credit for ethanol blenders.

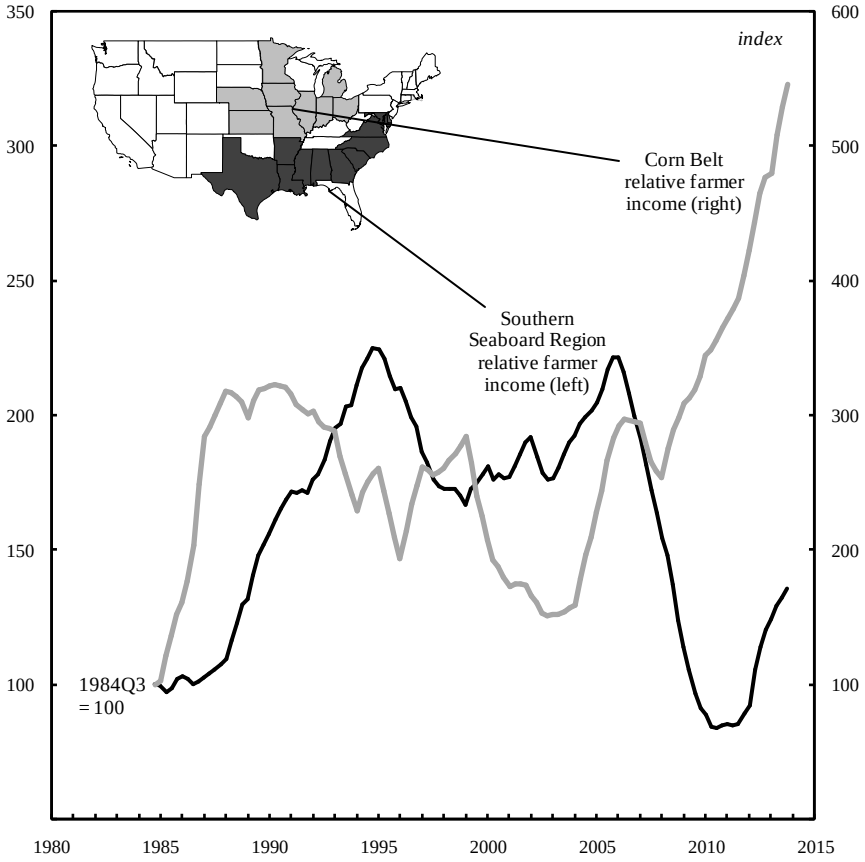

Figure 6: The Relative Income of Farmers in the Corn Belt and the Southern Seaboard Region

Note: The Corn Belt comprises Iowa, Illinois, Minnesota, Ohio, Kansas, North Dakota, Michigan, Kansas, Nebraska and Minnesota. The Southern Seaboard region is represented by Texas, North Carolina, South Carolina, Mississippi, Georgia, Virginia, Delaware, Maryland, Arkansas and Alabama. Farm income data consists of the net income of sole proprietorships and partnerships that operate farms. For more information regarding the computation of these data see www.bea.gov/regional/pdf/lapi2010.pdf. Farm income data collected for each state and then weighted according to the farm population of each state. Famer relative income data calculated by dividing this weighted income data by the average hourly earnings of nonfarm production workers for each year. Data are smoothed to 3-year moving averages. Farmer relative income data re-based at 100 in 1983 Q3,

Source: Farmers proprietors' income data from the Bureau of Economic Analysis through Global Insight; series code: YENTAF. Average hourly earnings data of nonfarm workers from the Bureau of Labor Statistics through Global Insight. Series code: AHE@US.Q. State farm population data from USDA NASS (2012) Census on Agriculture: http://www.agcensus.usda.gov/ and from the USDA NASS (2013b) Agricultural Resource Management Survey: http://www.ers.usda.gov/data-products/arms-farm-financial-and-crop-production-practices/.

Beyond lobbying for these measures, the firms of the Animal Processor nexus have been attempting to mitigate persistently high feed grain prices through rationalizing their operations. For example, Smithfield has downsized its hog production division in a bid to insulate itself from corn price inflation. In fact, in just a four-year span it has reduced its domestic exposure to corn markets by 40% through outsourcing more hog raising operations to nominally independent producers (Clyma 2011). More broadly, there has been a renewed focus on animal population control. From 2009 to 2011, the US chicken population flat-lined at 2.1 billion, while the US cow population fell by 2% to 92.7 million and the pig population declined by 3% to 66.4 million (FAOSTAT 2014). In the short term, the increased liquidation of existing animal stocks led to a large outflow of meat in the retail market, further pushing meat prices down relative to feed grain prices. However, in the longer term, the cutbacks have mitigated cash-flow problems caused by elevated feed grain prices and they have led to a recovery in the differential markup of the Animal Processor nexus, as shown in the right insert of Figure 5.

The Animal Processor nexus has also sought to offset adverse domestic meat consumption (see right insert of Figure 2) and relative feed price trends through capitalizing on the general 'meatification' of diets abroad (Weis 2010). International sales of Tyson Foods have increased from 11% of total revenue in 2005 to 17% in 2012 (Tyson Foods 2006, 2; 2012, 2). Similarly, Smithfield's corresponding international share of sales has risen from 15% to 24%, in the same period (Smithfield 2006, 23; 2012, 17). The rationalization of the Animal Processor nexus's domestic operations and the expansion of meat sales outside of the US have helped to reverse the decline in its differential capitalization, as depicted in Figure 5. Moreover, as the figure shows, these changes also seem to have contributed to a resurgence in the differential income of livestock farmers. Interestingly, the Agro-Trader nexus has perhaps contributed to the recovery of the Animal Processor nexus's earnings capacity, by supporting and facilitating the spread of meat-centered diets abroad. The support has been articulated in the discourse of the Global Harvest Initiative, for its policy statements continually equate social development with increased meat consumption (see for example Global Harvest 2013). And the Agro-Trader nexus has facilitated global meatification through encouraging the spread of agro-biotechnology and monocropping practices for feed grain production, and through setting up milling and distribution channels that process and deliver these feed grains to confined animal feed operations across the world. Thus, the tensions between the Agro-Trader nexus and the Animal Processor nexus regarding the corn-ethanol boom have partially been defused through the international expansion of the livestock-feed complex (Gereffi and Christian 2010, Weis 2013, Schneider 2014). The Animal Processor nexus has also benefited from the general slowdown of the corn-ethanol boom. To be sure, by the beginning of the second decade of the twenty-first century, the ethanol sector was producing more fuel than could be absorbed by existing fuel consumption in the US. Almost all of the fuel in the US now contains about 10% ethanol, and surmounting this 'blend wall'

will be difficult as higher percentages of ethanol used in fuel damages the engines of automobiles that are not built according to 'flex-fuel' specifications (Barnett 2013). The slowdown in the growth of ethanol production from a compound annual growth rate of 29% from 2005 to 2009 to a growth rate of just 5% per year for the four following years is reflective of a wider modulation in the power of the Agro-Trader nexus. As Figure 5shows, between 2009 and 2010 the Agro-Trader nexus's differential capitalization fell dramatically. The slowing growth in the diversion of corn into the ethanol sector (Figure 3) contributed to a decline in corn prices in 2009 and 2010 (Figure 2) and this in turn contributed to the emergence of a brief deflationary period within agriculture that the Agro-Trader nexus struggled to negotiate. In particular, there was a farmer backlash against Monsanto's genetically engineered Smartstax corn seed as the high price the company charged for it seemed to be completely unreasonable given its yield performance. Monsanto claims that it has now adjusted its pricing model. According to Monsanto's own figures, toward the end of the first decade of this century, the company sought to glean 50% of the extra profit that the introduction of its newly engineered seeds generated for farmers. Now, they have reverted back to their strategy of claiming one-third of the extra profits (Pollack 2010).[18] The moderation in Monsanto's pricing strategies, in the face of corn farmer discontent, perhaps contributed to the flat-lining in the differential markup of the Agro-Trader nexus in recent years, as depicted in the right insert of Figure 5. ADM, for its part, found that the margins of its ethanol processing division were caught in a cost-price squeeze due to the diminution in the differential between gasoline prices and corn prices (Blas 2012). Finally, Deere & Co. experienced reduced sales of its specialized crop agriculture vehicles, as falling crop prices reduced corn growers' willingness to make costly machinery purchases.

Although the Agro-Trader nexus is operating in accordance with the Animal Processor nexus in the promotion of global meatification, it remains in a deadlock with the Animal Processor nexus over the US ethanol sector . The sharp rise in corn-ethanol production from 2005 to 2009 corresponded with a rapid redistribution of power and profitability from the Animal Processor nexus to the Agro-Trader nexus. And in the following years, corn-ethanol production kept climbing, albeit at a slower pace. According to the latest estimates, by 2013, a record-breaking 43% of corn produced in the US was channelled into the ethanol sector. This figure is predicted to fall to 40% in 2014 (AgMRC 2014). Despite the apparent downtrend in the proportion of corn channelled to ethanol feedstocks, it is unlikely that the corn-ethanol sector will be dramatically curtailed for a number of reasons. Firstly, as the paper has argued, the

[18] Although we should perhaps be circumspect about these exact numbers, it does appear likely that Monsanto and DuPont are less inclined to enforce price hikes than before. According to USDA data, between 2005 and 2009, bioengineered corn seed prices increased at a compound annual growth rate of 16% per year, thus almost keeping pace with the 17% compound annual growth rate of corn prices in the same period. However, during the next corn price surge from 2010 to 2013, biotech corn seed increased in price by 5% per year, thus falling way behind the 13% compound annual growth rate in the price of corn itself. (Bioengineered corn seed price data obtained from the US Department of Agriculture (USDA NASS 2013a), For corn price data see source information of Figure 2.

companies of the Agro-Trader nexus enjoy a profound influence over the US government decision-making process and as a result, it is improbable that new policies and regulations will come to pass that substantially undercut their accumulation strategies . Secondly, the broader pro-ethanol coalition has significant electoral clout because two major 'swing states' – Iowa and Ohio - are in the Corn Belt. As such, US presidential candidates disregard the interests of corn farmers, and the nexus of agribusiness power in which these farmers are ensconced, at their peril. Thirdly, the possibility of non-edible biomass dislodging corn from its position as the US's premier ethanol feedstock looks extremely remote. In fact, the latest data show that second-generation agrofuels account for only 0.04% of total agrofuel production in the US (USDA ERS 2014). Due to seemingly insurmountable problems regarding their commercial viability, it does not seem likely that second-generation agrofuels will be a significant factor in the US energy sector for the foreseeable future. Given these considerations, the food/fuel complex will probably remain an integral, but perhaps somewhat diminished, feature of the US agrarian political economy. The pecuniary effects of the interstitial adjustments that are under way are clearly depicted in Figure 5. The great divergence from 2008 to 2009 in capitalized profit shares within agribusiness, and in income shares within agriculture, has been followed by considerable re-convergence in both differential capitalization and differential income trends. Whether this re-convergence in sectoral earnings for both agribusiness and farmers will translate into a levelling out of relative income differences across the regions of rural America remains to be seen.

Conclusion

Building on previous scholarship in agrarian political economy (Goodman *et al.* 1987), the food regime approach underscores the importance of the corporate appropriation of discrete phases of agricultural production, on the one hand; and the reconstitution of perishable foods into substitutable commodities, on the other. As Friedmann and McMichael argue, these processes of appropriation and substitution have eroded the autonomy of farmers over the agricultural process and they have also undermined the capacity of different governments to direct agriculture for national ends (1989). In the account offered here, I have sought to emphasize another major consequence of the decomposition of the world food system into discrete sectors: it can give rise to rivalry between corporate constellations that superintend different agri-food complexes. In this paper I have examined the rivalry between the Animal Processor nexus and the Ago-Trader nexus. While the former has appropriated control over distinct parts of animal-meat production, the latter has extended its pecuniary ambit over distinct parts of corn and ethanol production. Additionally, by underscoring the seemingly indispensable role played by corn for both of these axes of power, my analysis shows how processes of substitution can drive conflict between different groups of

agri-food corporations and between different groups of farmers. In the case of the US agrofuel boom, the dramatic increase in the substitution of petroleum for ethanol completely overwhelmed the Animal Processor nexus's rather limited capacity to replace corn with cheaper commercial feed with a comparable energy content.

As such, by shifting from an aggregate to a disaggregate perspective, I move the focus of analysis from the supersession of national government authority and farmer autonomy by capital in general, towards an examination of how both government organs and agricultural interests become enfolded into power struggles between different groups within agri-food capital. This disaggregating analysis offers novel answers to some foundational questions of agrarian political economy regarding (dis)accumulation and social differentiation. On a macroscopic level, the agrofuel boom may have increased the profitability of capital in general, as McMichael contends. But within the agrarian political economy of the US, the agrofuel boom can also be characterized as a vector of redistribution. The redistributional dynamics are multi-dimensional. By triggering the massive diversion of corn from the livestock-feed complex toward the food/fuel complex, the corn-ethanol boom shifted capitalized profit shares within agri-food capital, from the Animal Processor nexus to the Agro-Trader nexus. It also redistributed income shares within agriculture, from livestock farmers to corn growers. And the ethanol boom may have contributed to a shift in earnings within the livestock sector itself: from livestock farmers outside of the Corn Belt to livestock farmers inside the Corn Belt.

These findings have significant implications. In particular, the paper points to the potential of conducting further research that inquires into the ways in which redistributional struggles between farmers become co-articulated with redistributional struggles between agri-food corporations. Such research may deepen our analysis of the uneven geographies of agricultural development and it may nuance existing understandings of the relations of inclusion and exclusion, and resistance and incorporation, between farmers and agri-food capital. Furthermore, in specifying the winners and losers of the agrofuel boom, the paper points to the social forces that stand in the way of change within the corporate food regime. As my findings indicate, putting an end to corn-ethanol production would not only involve challenging the accumulation strategies of some of the most powerful agri-food corporations in the world, it would also necessarily entail confronting the interests of more than 400,000 corn farms in the US, many of which have a direct stake in the continued diversion of their output into agrofuel feedstocks (EPA 2013). Finally, the analysis underscores the importance of supporting farmer-led movements that operate at the margins of the corporate food regime. As activists, food regime analysts and agrarian political economists in this journal have long contended, locally-oriented polycultures, and peasant farming more generally, offer a vital alternative to the destructive directions in which agri-food corporations are taking the world food

system. In defending and advancing these forms of agriculture, we may be able to move away from a food regime that commits inordinate amounts of energy and resources to fuelling cars and feeding intensively reared animals, towards systems of provisioning that are fundamentally centered on nourishing humans.

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