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Short Note

The Rise of the Food Risk Society and the Changing Nature of the Technological Treadmill

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Academic Editor: Ross M. Welch

Received: 1 April 2016; Accepted: 17 June 2016; Published: 22 June 2016

Abstract: Economic development of transition and developed countries is associated with increasingly unhealthy dietary habits among low-income population segments. Drawing on Ulrich Beck's sociological theory of risk society, the present research note calls attention to the positive relation between national economic development and food risks that result in the rise of food-related diseases and healthcare costs. On this basis, we argue that the knowledge-intensive agribusiness may translate Cochrane's technological treadmill into Beck's risk treadmill that shifts a growing share of food-related healthcare costs from producers toward consumers, state, and the healthcare system. This argument motivates a novel research program dealing with the "food risk treadmill" that emerges in response to modern farming and agribusiness practices. Awareness of the food risk treadmill may help to streamline the development of agricultural science and to prevent it from being excessively dominated by the agricultural and food industry.

Keywords: agricultural treadmill; risk shifting; risk society; Ulrich Beck; knowledge

1. Introduction

Sooner or later, countries enjoying a sustained growth in their national incomes get confronted with the increasing healthcare costs caused by the spread of non-communicable diseases, such as obesity, cancer, hypertension, and heart dysfunctions [1–4]. The paradoxical positive relationship between economic welfare, food risks, and healthcare costs has already been pointed out by researchers from different fields as well as by various international organizations [5] (p. 25), [6–9].

This relationship appears to be especially pronounced in developed counties. For example, in the USA, healthcare costs have been rising faster than national or personal income for more than 40 years [2] (p. 125). In low- and middle-income countries, these costs are much lower but still positively correlated with the level of economic development measured in terms of national income and urbanization [10–12]. Recent research shows that rising average incomes in emerging economies go along with the rise in nutrition-related chronic diseases [1,3,13], especially for low-income population segments and for urban children who are exposed to energy-dense foods that are low both in cost and nutritional quality [14] (p. 124). Part of this problem is probably caused by the globalization of agriculture and the increasing disconnection between the places of food production and consumption [15] (p. 3532), [16]. With "rapid shipping methods and the global distribution of food, serious public health risks and food hazards in one part of the world can be transferred to other parts of the world in a matter of hours or a few days" [17].

The World Health Organization (WHO) already speaks of the global transition from traditional health risks (e.g., undernutrition and exposure to infections) to modern health risks (e.g., urban air

quality, changing dietary habits, and sedentary lifestyles) that cause the increase of chronic diseases such as ischemia, cancer [7] (p. 9), and the "global obesity epidemic" [3]. Interestingly, the latter risks not only coincide with the top five health risks of high-income countries and with the top four of the middle-income countries, but also constitute the five leading causes of global mortality [7] (p. 11). By contrast, the major health-related risk factors in low-income countries are still associated with underweight, infectious diseases, and micronutrient deficiencies. Low fruit and vegetable intake is not documented among the top ten risk factors in these countries, even though it is ranked seventh and eighth for high- and middle-income countries, respectively [7] (pp. 9–11). The low-income population segments appear to be most affected by food risks in any country. In high-income societies, however, these risks are primarily induced by industrialization and take the form of overnutrition and attendant healthcare costs [9] (p. 449).

The link between economic development and the changing nature of food risks is echoed by the sociological theory of risk society developed by the German social theorist Ulrich Beck [18]. Mounting a critique of modern industrial practices, Beck [19] (p. 216) argues that man-made risks, including crime, pollution, and non-communicable diseases, are no longer a manageable side effect, but rather the very products of the knowledge-intensive industrialized modernity: "the industrial pollution of the environment and the destruction of nature, with their multifarious effects on the health and social life of people [. . .] only arise in highly developed societies" [5] (p. 25).

There is indeed abundant evidence that food risks are especially high in advanced countries that heavily rely on knowledge-intensive production and management practices [1–4,6–14]. While technological progress is supposed to make human life easier and safer [20] (pp. 2–3), each technological advance—be it a standardized workflow, the use of herbicides, or nuclear energy—unavoidably produces manifold risks which include car accidents, toxins in foodstuffs, and nuclear threat [5] (p. 21), [21,22] (p. 319). The paradox of the technology-based modernity exposed by Beck consists in the tendency of technologically induced risks to demand risk mitigation in the form of ever-new technological solutions that in turn bring risks of their own. This circular cumulative risk-technology causation creates a risk trap or treadmill [5] (p. 177), [19] (p. 218), [23].

The connection between technological development and the cumulative "race to the bottom" in the nexus of risk and technological progress has also been noted by agricultural economists, though in a different context. Willard Cochrane advanced the idea of the technological treadmill in his seminal book "Farm Prices: Myth and Reality" originally published in 1958 [24]. Ever since, the technological, or agricultural, treadmill has served as a paradigmatic point of departure for understanding structural change in agriculture. Cochrane argued that the use of improved technologies in agriculture not only increases productivity and reduces food costs, but also brings about the consolidation of land and ownership that in turn calls for further technological improvements. All over the world, the ongoing structural change in agriculture and the attendant increasing use of technological advances in the organization of agricultural production lend credence to Cochrane's theory. The present paper contends, however, that the technological treadmill tells only a part of the story. Another part, which is inspired by Beck's risk treadmill, is that these technological advances reframe agricultural practices and structures in such a way as to shift health risks and costs from producers through the processing and retailing industries to consumers, but also to governments (e.g., via taxpayer-supported subsidies to farmers), healthcare systems, and future generations [25] (p. 39). Given that the production of food and the generation of food risks are inherently related, we argue that the shifting of risks and costs is the endemic consequence of Cochrane's technological treadmill. The present research note underscores the role of industrialized agriculture (both, the farming sector and the vertically integrated agricultural value chains) in shaping the interlinkages between both treadmills. To this end, we first sketch out the effects of Cochrane's technological treadmill on the trend toward industrialized agriculture and technologically induced risk shifting. Then, we present the central ideas of Beck's risk society theory and show their relation to the problem of food risks. The paper concludes by suggesting a research agenda on the nature of the food risk society.

2. Cochrane's Technological Treadmill

Cochrane's theory of the agricultural, or technological, treadmill describes causal connections between technological innovations, production cost, farm returns, competition, and farm size that put the agricultural sector under permanent adjustment pressure [24]. The treadmill explains the ongoing trend in global agriculture toward larger farms. Productivity improvements allow a relatively small number of farmers, who are early adopters of new technology, to reap temporary profits. As more farmers adopt the new technology, overall production goes up and pushes prices down, rendering further profitable operations impossible. To stay in the market, farmers are forced to get on the treadmill and adopt the next new technology. Those farmers who cannot do so, particularly smaller farmers, incur above-average production costs that cannot be recovered at the lower output prices. Non-adopting farmers thus face growing pressure to exit agriculture and to become passive landowners [26]. In the latter case, the land resources of the non-adopters are often acquired by the successful early adopters. Thus, it comes about that every turn of the technological treadmill leads to an increasing farm size and a decreasing number of farms. The necessity for technological innovations opens up new prospects primarily for larger producers, while producers that are smaller and less efficient are getting squeezed out of business.

Cochrane's treadmill is traditionally believed to promote the interests of the industrial sector of the economy by facilitating the inflow of labor force released from agriculture [27]. Consumers are likewise supposed to benefit from the decreasing costs, larger output, and improving quality of food. The rising concerns over food risks suggest, however, that this belief may be overly optimistic. Benefits of improved production efficiency (e.g., low food prices or higher sanitary standards) are not necessarily passed on to consumers and other concerned stakeholders. What is likely to be passed on to these stakeholders is the food, health, and sustainability risks (e.g., overconsumption of sugar, unbalanced diets, and biodiversity losses) associated with higher production efficiency. The coexistence of the technological treadmill and the risk treadmill poses the issue of their possible interrelation. The technological treadmill likely aggravates the risk treadmill discussed in the next section.

3. Beck's Theory of Risk Society

Beck [5,18,19] makes his case for the risk society by tracing the evolution of manufactured risks in the course of the transition from the industrial society (*i.e.*, the first modernity) to the risk society (*i.e.*, the second or reflexive modernity). The first step of this transition, spanning the period from the beginning of industrialization in the 17th century to the early 20th century, involves the systematic and unintended production of manufactured risks, which, so the belief goes, can be institutionally controlled. The possibility of their control rests on their amenability to mathematical assessment using empirical knowledge of past accidents and probabilities [19] (pp. 215–216).

In the second step, the sheer diversity and complexity of multifarious risks render their institutional control impossible. Absent the possibility of control, the monitoring and protective institutions of the first modernity turn into the legitimators of risks of the second modernity. The latter risks are no longer simply "a matter of unintended consequences—the 'toxin of the week'—but also of the unintended consequences of unintended consequences in the institutions" [19] (p. 222). This transformation of risks engenders the rise of organized irresponsibility, referring to the state of society in which nobody is responsible for the origins and consequences of the catastrophic risks of the late industrialization [18,19] (p. 224).

Unlike earlier tradition-based cultures, the second modernity is guided not by past events and lessons learned from them, but primarily by future visions. This means that the perceptions of possible threatening events in the future determine present-day thoughts and actions [19] (p. 214), [28]. In the financial world, these perceptions are exemplified by the use of the so-called memory-less stochastic (or Markov) processes for mathematical predictions of expected prices or derivative values. In the more general societal context, the reversed time preference is evidenced by the attenuation of the authority of traditions as well as by the "social surge of individualization" [5] (p. 87).

Consequently, within the second modernity, social stratification is determined by the distribution of risk rather than of wealth. Even the wealthiest individuals or groups may be unaware of relevant risks and unable to avoid or shift them. In a sense, risk is more democratic than wealth because of its equalizing effects [5] (p. 36), as well as more cosmopolitan in view of the advancing globalization [15,16]. It is, however, noteworthy that the uneven distribution of risk does not alter the relations of social inequality, but does change the distributional logic to that of social "immi[z]eration" [5] (p. 50 ff.) and "a loss of social thinking" [5] (p. 25). In this line, Champlin and Knoedler [29] document the reallocation of healthcare costs in the economically advanced countries in response to the presumption of an individual's own, rather than collective, responsibility for his/her health.

Beck goes to great lengths in exposing the role of knowledge in the technologically advanced second modernity. He even defines the very notion of risk in terms of a "peculiar synthesis of knowledge and unawareness" [19] (p. 26), (*cf.* also [20] (p. 3)). Paradoxically, the growth of knowledge, while giving a boost to industrialization, brings about new types of manufactured risks. It is interesting that a similar story can be told about Cochrane's treadmill. Technological knowledge does present the source of technological improvements. Yet these improvements only allow agricultural producers to stay in the same place, and only on the condition that they continue to participate in the race. In both treadmills, the role of knowledge is ambivalent, and it is probably this ambivalence that explains the wary public attitude toward scientific expertise in many contemporary debates, such as those on genetically modified organisms and industrialized agriculture. The case for the ambivalent role of knowledge is further reinforced by its growing control by industry (e.g., in terms of contract research), which is not terribly sensitive to social and ecological consequences of technological innovations.

4. Connecting the Technological and Risk Treadmills

4.1. The Common Systems-Theoretic Core

Why is the juxtaposition of the two treadmills justified? Both of them conjure up the image of social systems following their internal logic and imperatives while maintaining a precarious relationship to their environment. Fanciful as it is, this image is at the core of Niklas Luhmann's systems-theoretic approach to social theory. Luhmann (e.g., [30]) saw the primary function of social systems in complexity reduction, *i.e.*, the relieving of individuals of the intolerable cognitive burdens related to processing the complexity of the social and natural environment. While this function is valuable, it is not a "free lunch" [31]. Social systems fulfill it at the cost of disregarding the environmental complexity, thus exposing themselves, and the modern society as a whole, to multifarious environmental risks. Valentinov [32] (p. 14) referred in this connection to the complexity-sustainability trade-off, which "emerges because the growing systemic complexity entails the increasing risk that systems develop insensitivity to those environmental conditions on which they critically depend". If the complexity-sustainability trade-off is accepted as a characterization of the endemic problems of modernity, then it naturally follows that "the institutions of industrial society produce and legitimate hazards which they cannot control" [19] (p. 223).

In the context of farming and agribusiness, the growth of the precarious civilizational complexity takes the central form of the accumulation of scientific and technological knowledge (Figure 1). Following Luhmann's vision of functional differentiation as a key feature of modernity, this knowledge can be plausibly taken to be processed by the economy as one of the function systems (along with other systems such as science, law, and politics). The complexity-sustainability trade-off implies that the building up of this intra-systemic complexity will likely result in the disregard of the critical dependencies of the economic system on its societal and natural environment. It is this disregard that brings farmers and consumers into a precarious condition described by the technological and risk treadmills. With regard to farmers, the complexity-sustainability trade-off plays itself out through the heightened dependence of agricultural production on the natural environment. Even though this

dependence is somewhat weakened by agricultural technologies, it still prevents at least some farmers from developing effective complexity reduction strategies. This is especially likely for small-scale farmers who find themselves unable to control their technological interdependence at a level that would be sufficient for escaping collectively suboptimal outcomes laid bare by Cochrane [24]. The case of consumers is more straightforward. They are on the receiving end of social costs generated by the economic system, with food risks being an increasingly prominent cost component.

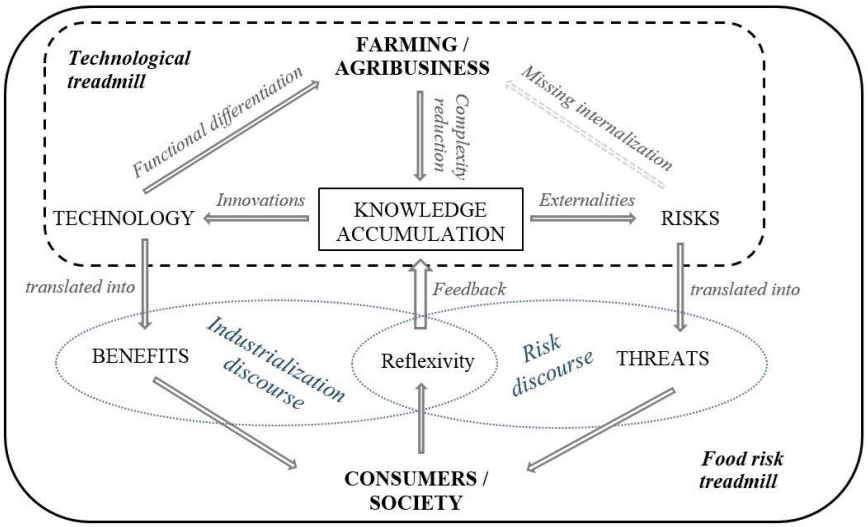

Figure 1. Connecting the technological and risk treadmills.

The common systems-theoretic nature of the two treadmills points to their moral implications. Balmann *et al.* [33] have argued that the technological treadmill lowers the capacity of agricultural producers, large-scale and small-scale alike, to assume corporate social responsibility, thus deepening the cultural rifts between agriculture and broader society. The ongoing exacerbation of food risks fits only too well into this pattern. At the same time, the treadmill metaphor drives home the point that any individual ascriptions of responsibility and blame would be contestable and unhelpful. In Beck's words, "risk societies are characterized by the paradox of more and more environmental degradation—perceived and potential—coupled with an expansion of environmental law and regulation. Yet, at the same time, no individual or institution seems to be held specifically accountable for anything" [19] (p. 224). Valentinov *et al.* [34] note in this connection the "emergent" character of modern moral problems, such as that of climate change. There are few doubts that "global warming is one of the most urgent and serious problems facing humankind. Yet [. . .] many people neither understand nor accept the conclusions of the science of climate change" [35] (p. 197). According to Valentinov *et al.* [34], the dysfunctional consequences of moral communication can be prevented only if it is framed by those "semantic forms that take account of the emergent properties of the economic and other social systems" [34] (p. 1). It seems that, in the agribusiness and farming context, the search for these forms may be expediently conducted on the terrain staked out by the ongoing discourse between the so-called industrial and agrarian philosophies of agriculture.

4.2. The Two Philosophies of Agriculture and the Role of Agricultural Knowledge

The debate between the industrial and agrarian philosophies of agriculture, lucidly presented in Thompson's seminal book "The Agrarian Vision: Sustainability and Environmental Ethics" [25], focuses on those dimensions of agriculture that make it significant in civilizational, societal, cultural, and even spiritual respects. At bottom, this is a debate on "how can we make our society and our lives more sustainable?" [25] (p. 1). In the present context, this debate draws attention to the dual nature of knowledge whose dynamics is fueling both treadmills under discussion. If the stance of the industrial

philosophy of agriculture is correct and agriculture indeed presents just another sector in the industrial economy, then the ongoing generation of food risks and the systematic squeezing out of small farms present implications that are not only unavoidable but also morally legitimate [25] (pp. 30 and 45), [36]. While acknowledging the built-in tendency of industrial agriculture to generate externalities, or social costs in a more heterodox parlance, Thompson certainly does not deny its capacity to internalize at least some of them. The more important point is that the continual generation of social costs, including food risks, is hardwired into the economic logic of agricultural industrialization, which makes food not only cheaper and more abundant but also equitably distributed [36,37] (pp. 137 and 177). The social costs imposed on those small producers who are forced to exit agriculture are likewise justified by the industrial philosophy in terms of benefits of abundant labor supply to other sectors of the economy [27].

Yet the industrial philosophy does not seem to hold an exhaustive view of agricultural knowledge. It is true that knowledge makes both treadmills rotate not only faster but also with a greater reach. Still, it seems no less clear that the improvement of social and ecological sustainability must likewise be knowledge-intensive, even though the knowledge required for this purpose is of a different kind than that which is prominent in the industrial philosophy. It is at this point that the agrarian philosophy of agriculture makes a unique contribution by calling attention to "the larger wholes in which both human relationships and exchanges with nature acquire their meaning" [25] (p. 38) and by emphasizing the relation of agriculture to the moral values of sustainable development. The agrarian philosophy encourages agricultural producers to "find new ways to establish lines of feedback on our use and abuse of natural resources", with the hope that "these new ways must kick in well before the Malthusian controls of famine and warfare" [25] (p. 194). Finding these ways is not only a moral but also an intellectual task calling for an intimate knowledge of natural ecosystems, communities, and human responsibilities for addressing risks of industrial agriculture.

Acting on this knowledge certainly calls for institutional forms that likely differ from those implicated in the industrial philosophy. Balmann *et al.* [33] refer to civil society and corporate social responsibility; Thompson [25] sees a role for community-supported agriculture, food activism, and rural cooperatives [38–40]. The important point here is the acknowledgment that the agricultural knowledge envisioned by the industrial philosophy of agriculture is not the only possible type of such knowledge. Whatever they are, the moral values of agriculture and sustainable development sensitize us to the need for acquiring those varieties of agricultural knowledge, which are not only helpful for internalizing the existing risks and social costs but also for forestalling their emergence in the first place. The present agricultural knowledge is the foundation for the dominant industrial development paradigm. If the post-industrial paradigm has any chance, it will be knowledge that would help it to get off the ground.

5. Toward a Research Agenda

If the concerns about the link between Cochrane's technological treadmill and Beck's risk treadmill are valid, these would justify a novel research program on how Cochrane's treadmill is linked to new financial, ecological, and social risks that are increasingly shifted from producers toward consumers, the state, and the healthcare system. According to Beck [5], these risks emerge through institutions that regulate the production and control of food risks. Consequently, exploring the interlinkage between the technological and risk treadmills challenges the popular belief that the technological treadmill confers pure benefits on food consumers. Instead, the embeddedness of the technological treadmill into the encompassing risk treadmill entertains the possibility that the emerging agricultural technologies promote risk shifting and thus turn food production partially to the consumer's (and thus the broader society's) disadvantage [41]. The present research note proposes to address these issues by interlocking the mechanisms of risk externalization and internalization within both treadmills (Figure 1).

Risk production within the technological treadmill is a consequence of economic actions and strategic decisions of agricultural producers. Exploring risk production accordingly requires the

verification of doubts that are occasionally cast upon the existence of this treadmill in the present-day agriculture [42]. This task calls for analyzing the general trends in farm sizes and numbers, in the share of population employed in agriculture, in the agricultural sector's contribution to GDP, and other relevant statistics of countries at different development levels. In the next step, risk shifting from agricultural producers to consumers and the society at large can be detected by analyzing the reasons for and the mechanisms of the correlation between land use (and modern agricultural practices) with diets and nutritional content of foods, as well as the food and healthcare costs. One of those mechanisms is suggested by the dependence of the corporate social responsibility practices on the pace of the technological treadmill.

Risk shifting, however, is not necessarily linear and one-directional. Besides being the risk externalization strategy of producers, risk shifting may be unintentionally accelerated by consumers' neglect of their own responsibility for diets and health. This is especially true for consumers that enjoy increasing income levels. Following Engel's Law, income growth should benefit consumers by lowering the proportion of income spent on food. In reality though, this process is often accompanied by a decline of dietary balances and the related increase of food risks, especially for low-income populations [43]. Consumers' contribution to the food risk treadmill must therefore be recognized as potentially non-trivial and susceptible to the influence of civil society initiatives. Changes in dietary habits can be accordingly investigated not only as the consequence of decreasing food prices and increasing incomes but also as expressions of social reflexivity framed by a wide array of ideologies, ranging from the politics of food self-sufficiency [44] to cultural reinforcements of agricultural myths [45].

Another area of inquiry is the potential trade-off between the health benefits (such as the lower germ load) and health risks (because of, e.g., toxic residues or reduced nutrient content). If this trade-off exists, it can be detected by differentiating between the types of technological progress, which can be purely technological, qualitative, or organizational.

Other crucial research issues shown in Figure 1 include the discourses on risk and on the industrialization of agriculture. The distinction between these discourses goes back to Luhmann's [46] concept of second-order observation that is applicable to two types of risk observers: risk producers and risk bearers. Risk discourse arises out of the tendency of the consumers' perception of risks to "determine thought and action" in the era of the risk society [19] (p. 213). This discourse deals with the public and policy stance on issues related to agricultural industrialization (e.g., GMO or large-scale farming) as reflected by ongoing political and media debates. For the "existence and distribution of risks and hazards are mediated on principle through argument"—not, as in the case of consumable goods, through market or evidence [5] (p. 27). A potentially provocative implication of this conjecture is that the discourse on the industrialization of agriculture is seriously incomplete if it leaves the risk treadmill out of account. Today, it becomes increasingly clear that the future of agricultural industrialization is intertwined with the way both agricultural producers and consumers respond to manufactured risks. Both of these forms of reflexivity influence the food risk treadmill by interlocking growing knowledge with dietary choices and trends (e.g., from self-prepared meals toward convenience foods) and by encouraging the scholarly analysis of relevant civil society initiatives on the part of NGOs, food activists, and mass media.

Moreover, the study of the knowledge accumulation process may reveal a strong control of science by the food industry. If this is the case, then civil society would need to mobilize itself in order to overcome the consequences of 'organized irresponsibility' and to stand up to the challenge of the reflexive handling of knowledge, social learning [47], and scientific expertise. This challenge can be operationalized by studying the dynamics of the public spending on health, education, and science, trends in contract research, the relationship between the share of population employed in agriculture, and the quality of scientific expertise (*cf.* [27] (p. 104)), both in urban and rural areas. In addition, much can be learned from studying the correlation between the level of education and modern food health risks.

If successfully carried out, the proposed research agenda will have major impacts on international development policies, science, and food ethics, especially in the middle-income transition economies, such as Mexico, Russia, India, or Thailand [48]. These countries are approaching the bifurcation point at which they must decide on whether to pattern their long-term development on the Western model. In fact, already now, these countries resemble high- rather than low-income countries in terms of dietary habits, industrialization level, socio-economic disparities, occurrence of non-communicable diseases, and the share of healthcare costs borne by households [10]. The proposed research agenda may alert decision-makers in these countries to the opportunity of avoiding excessive ties between science and the agricultural and food industry. It is likely that the awareness of these problems may advantageously inform those international policy recommendations that consider the transfer of Western technological solutions as the most effective development assistance [11,49].

6. Concluding Remarks

Technological progress is generally supposed to make human life easier and safer. However, the remarkable contribution of Ulrich Beck is in showing that this progress seldom occurs without the unfortunate emergence of manufactured financial, ecological, and social risks. While heterodox economists have long been concerned with the social costs of economic development (e.g., [50]), Beck's risk society theory generalizes this problem setting to the risks induced by the modernization process which transforms the entire society, including the non-economic spheres. As Beck showed, the societal impacts of manufactured risks go as far as to restructure the very principle of social stratification. This principle is no longer wealth, but rather the ability to protect oneself from risks. Beck's work informs modern agricultural economics by pointing out the circular cumulative causation between risks, knowledge, technology, and industrialization of agriculture.

This research note argues that in the contemporary agricultural context, this causation is further radicalized by its interlocking with Cochrane's technological treadmill which must be suspected of shifting the growing share of food-related costs from producers towards environment, consumers, state, and the healthcare system, a suspicion warranted by the positive relation between national economic development and food risks. To validate this suspicion, the paper suggests a novel research program that explores the shaping of food risks by modern farming practices and agricultural structural change.

Acknowledgments: The authors are grateful to anonymous reviewers for their very helpful comments.

Author Contributions: All authors contributed roughly equally to the paper.

Conflicts of Interest: The authors declare no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

GMO	genetically modified organism
NGO	non-governmental organization
OECD	Organisation for Economic Co-operation and Development
U.S.	United States
WHO	World Health Organization

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