Accounting for the Wealth of Denmark: A Case Study of Smithian Growth Using the Emergence of Modern Accounting in Danish Dairying

Abstract: The idea of “Smithian growth” rests on a “natural” development out of agriculture through capital accumulation, and the division of labour. We confront these concepts with an “historical experiment” and the case of Danish agriculture in the nineteenth century. Specifically, we look at how accounting was used to promote specialization, ultimately in butter production, leading to the massive increases in productivity that Smith predicted. We also observe the emergence of Smithian “philosophers”. This ultimately led to the capital-intensive industrialization of Danish agriculture through butter factories, and general development. We argue that this establishes the historical relevance of Smith’s theories.

JEL codes: B1, B3, M4, N5

Keywords: Accounting, bookkeeping, dairies, Denmark, Smithian growth, Adam Smith

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1. Introduction

Smithian growth has often been treated as “a poor relative among theories of economic growth” (Kelly 1997, 939), although there has recently been a “Smithian revival” of interest in his thought about this (Schumacher 2016). Our contribution to this is to consider the concept of “Smithian growth”, how this should be defined, and, in particular, the relationship between two mechanisms Adam Smith proposed. The first is his concept of “natural” development out of agriculture, based on capital accumulation and the search for alternative uses for capital, and the second is his concept of division of labour (opportunities for which he considered to be limited within agriculture), which most consider to be his fundamental contribution to understanding growth. Both the definition as well as the interrelatedness of these terms remains unclear in the literature, and cannot easily be settled within the history of economic thought (see Schumacher 2018 “vs.” Blecker 1997), since Smith himself is not explicit about this. Thus, the debate can in a sense be boiled down to the question of whether book I (division of labour) or book II and III (natural order of opulence) are his “real ideas”; as well as whether he was in fact seeking to explain European development (which he himself calls unnatural) at all. Another related issue is whether or not the division of labour as conceived by Smith is confined to the national level, or whether an international division of labour is possible, thus motivating a case for an “international trade”-“development” nexus.

In the present work, we propose to use an “historical experiment” based on the economic history of Denmark to understand the relationship between Smithian “natural development”, the (international) “division of labour”, and the role of agriculture for this. Denmark began its transition from an “unnatural order” (of feudalist and mercantilist distortions) to a more “natural” one (based on agricultural development apparently inspired by Smith and the French physiocrats, and abandonment of mercantilism) from about 1780, although this was soon followed by crisis and hiatus until at least the 1830s due to the Napoleonic Wars. Elsewhere, international markets integrated as mercantilism was eventually abandoned everywhere, most famously with the UK’s repeal of the Corn Laws in 1846, thus shaping an international environment closer to Smith’s “natural conditions”. We use the Danish example to illustrate the
dynamics of adjustment as institutional and technological transaction costs declined, demonstrating how agriculture became more efficient, and how the transition to further stages of development came about. We demonstrate both how widening the extent of the market affected producers, but also how producers in turn specialized and extended the market still further. As the basis of our analysis, we take inspiration from Bryer’s (2000a, 2006a, 2006b, 2017) concept of “accounting signatures”, using unique real-time data on how actors in Danish agriculture adapted during this period, based on their bookkeeping, accounting, and the related discussions which mostly played out in the Danish scientific journals, notably Tidsskrift for Landøkonomi (TfL, the journal of the Danish Royal Agricultural Society, mostly representing the large, often noble, landowners) and Ugeskrift for Landmænd (UfL, for medium-sized farmers). Although economic theory is often based on preceding “history”, economists generally test these models on subsequent data. Economic historians, on the other hand, mostly use current theories (and methods) to understand past events (cf. Backhouse 2002). Here, we instead make the experiment of confronting historical theories (embedded in current explanations of them, in a “limited rational reconstruction”) with historical evidence from a period shortly after they were formulated, with the aim of finding out whether this yields insights into empirical economic history that can, potentially, in a Smithian cumulative circle, feed back into understanding some key issues in the history of economic thought. Specifically in this case this concerns how to make sense of the cleavage between “natural paths to opulence” and the role of commerce for development in Adam Smith’s Wealth of Nations (Smith [1776] 1976, in the following: WN).

We thus attempt a rational (and in part historical) reconstruction by embedding Smith into the material context of his time (Schumacher 2012). Our inspiration came principally from the work of the late Karl Gunnar Persson (1988; see also his textbook exposition in Persson and Sharp 2015), who proposed Smithian growth – in short, population growth and market integration leading to division of labour and technological development – as the basis for understanding preindustrial economies. We do not, however, attempt to present new insights about Smith and WN. Moreover, our focus is on the specialization-/trade/-growth nexus, not on Smith’s views on foreign
trade (which are highly interwoven with his general critique of mercantilist policy). We
instead embed the distinction between domestic and foreign trade into the economic
situation/market integration story of the late eighteenth century, a time when markets
began integrating (see e.g. Sharp and Weisdorf [2013] on the grain trade with the North
American colonies), followed by the shock caused by the Napoleonic War, and the
subsequent resurgence of protectionism, before the liberalisation and trade of the “first
era of globalization” of the second half of the nineteenth century, at which point
conditions more akin to those considered “natural” by Smith re-emerged.

We thus argue that the nineteenth century, and specifically developments in Danish
agriculture at that time, provides an ideal opportunity to understand the importance of
Smith’s contribution. Besides the unique “real time” data on the process of the
development of accounting, which we will demonstrate was used to spread
technological knowhow and discover what to specialize in, this was also of great
importance for the development of the country as a whole, which underwent an
unusually rapid and successful agricultural transformation in the second half of the
nineteenth century. Danish farmers sought through accounting to describe and
understand the internal flows involved in managing cattle with the goal of maximizing
output and income from animal husbandry, initially with a focus on obtaining natural
fertilizer, manure, the key ingredient for sustainable premodern agriculture, in the most
efficient way (cf. Lampe and Sharp 2017). This same technique was then refined to cover
an ever-wider range of potential production decisions regarding by-products (for
example pigs raised on waste dairy products for bacon production), additional inputs
(such as fertilizer not produced on the farm) and production technology choices (for
example whether to use milk to produce cheese or butter). Eventually, those techniques
diffused through the Danish agricultural sector, became standard curriculum at the
Royal Agricultural and Veterinary College and agricultural schools, and led to annually
published dairy survey tables of feeding, production and revenue that individual farms
could benchmark their results against. All this took place in the context of the
unprecedented rise of the Danish dairy industry, which came to dominate the important
British market for butter and bacon from the last decade of the nineteenth century both
in quantity and quality, largely produced by cooperatives, which emerged from the
1880s once a new technology (the steam-powered automatic cream separator) allowed for the centralization of production from many geographically dispersed peasant producers (Henriksen 1993).

We are of course aware that this work relates to a large literature in accounting history, which we by and large abstract from for the purposes of this paper. Specifically, a well-known narrative depicts the origins of modern cost and management accounting as a rational response to the development of the modern firm as an ever more complex organism with a myriad of internal material flows and different tasks that required an advance in accounting techniques in order to maintain the integration of its organizational structure. More sophisticated techniques thus followed from demands for more information and led to a better structuring and more efficient processing allowing for the management of these larger quantities of information. Better decision making and increased efficiency in processing of inputs would in turn enhance economic growth at a firm, industry, national and world level (Chandler 1977; Johnson and Kaplan 1987). Most accounting historians argue, however, that in practice the evidence linking the introduction of sophisticated accounting techniques to efficient decision-making is thin, and that what actually happened was that a desire to measure, quantify and monitor was being imposed on the firm by interested parties (Miller and O’Leary 1994), or that the imposition of accounting might have been for the sake of class interests and profit maximization and the appropriation of surplus generated by labour (Bryer 2000a, 2006a, 2006b, 2017), or, denying the primacy of economic forces, it might have been due to mechanisms aiming at disciplining workers and managers so that they became “responsible” (Hoskin and Macve 1994).

For the most part, however, the setting for this debate is industrial firms: the factories and corporations born during industrial revolutions. In agriculture, however, it was not costing decisions in multi-product firms and a managerial grip on ever-growing organizations that was the key problem, but rather how to adapt a growing body of knowledge about local conditions of soil, climate and market access in a way that gave the possibility of profiting more from the increasing national and international market integration which took place from at least the 1840s, with the resultant increased access to international markets for inputs and outputs. Contrary to what is described as having
taken place in industry (Johnson and Kaplan 1987, 19–23), in the case of agriculture few external transactions were internalized. Rather, decisions had to be taken as to whether primary products (such as grains) were better sold directly or processed on the farm (by feeding to cows or bulls to obtain manure, milk, butter and meat), how to increase the value added and to improve the production of the land (through better fertilizing, more grain output, etc.), and whether buying and incorporating external resources (“artificial fertilizers” such as guano and feed concentrates for example) and technologies made sense. On the other hand, from the very beginning, this was largely focused on management decisions for the production process. Moreover, at least in dairying, the regime of measurement and control, while it was largely required to be performed by – mostly female – workers, was not directed at labour, but at the central capital product in the production process, the cows. In fact, even the individual cow does not seem to have been as much the centre of attention as the practices of feeding and breeding at the herd level.

The remainder of this paper proceeds as follows. In the following section we provide a brief overview of Adam Smith’s theory of growth and the debates around this. In section 3, we propose a framework for understanding and potentially resolving these debates through the economic history of Denmark, which we then illustrate empirically in section 4. Section 5 concludes.

2. What is Smithian growth? Two views

Estate management was central from the birth of economics, for example in Xenophon’s *Oikonomikos*, and with it the idea of agriculture as the backbone of the economy. Xenophon’s treatise emphasizes aspects of business administration, leadership and credible authority in managing the human resources on a farm (including slaves) for self-sufficiency, and thus hierarchy, over interactions on markets and the division of labour. While Xenophon was familiar with the division of labour between artisans, the exchange between estates and towns is conceived of as an exchange of surpluses, and division of labour on the farm is relegated to the kitchen, where task specialization should lead to nicer food (Backhouse 2002, 16–17).
Skipping more than 2000 years of history of economic thought, similar considerations, though worked out much more in detail, are still present in Adam Smith’s WN, and the recent literature dedicated to it. In today’s mainstream economics, Smith is identified with two pieces of economic theory, which are related to each other, but generally not integrated into one framework: the first is the erroneous, “doxographic” (Schumacher 2012), but oft-cited idea that Smith argued that (international) trade was guided by “absolute advantage”, while the second concerns a set of theories of economic growth based on specialization “caused by the geographical expansion of markets” (Kelly 1997). Both can be related to one another by a true understanding of the first, and by integrating it with the second into a “rational reconstruction” (Schumacher 2012) of Smithian economic growth based on Smith’s account of the division of labour in book I of WN.

Thus, we must first start by highlighting that Smith’s view of gains from trade and specialization was not a crude version of Ricardo’s theory for two reasons (Schumacher 2012). First, Smith did not in fact argue for division of labour according to absolute advantages, and, more importantly, his theory was not static and cannot be reduced to a simple statement that “countries are different in autarky, and therefore they trade when they open up”. A truly “Smithian view” of trade (Buchanan and Yeon 2002; Tribe 2006; Schumacher 2012) can then be better understood as dynamic and self-reinforcing: people trade because “Trading is, quite simply, a more efficient means of producing” (Buchanan and Yeon 2002), and this does not require initial differences, just the recognition of the availability of gains from trade in general, which emerge as trade is taking place. Division of labour then endogenously leads to increasing efficiency in production, which in turn, encourages more trade and a deeper division of labour in a cumulative circle (WN IV.i.31; cf. West 1988, 15, 19).

This link between trade, the division of labour, technological progress and economic development then runs through three channels (Elmslie 1994b; Elmslie and Jones 1993). The first two stem from the task-division of labour (see WN I, I, 6–9), and can be understood as operating through two mechanisms. First, there are “economies of practice” (improvement of “dexterity” in Smith’s words), as the individual that specializes in a task becomes more efficient at performing it through repetition, and no
longer wastes time by transitioning between different tasks. Second, there is “learning by doing”, as the specialized individual improves the production process through, for example, better and more specialized tools (in Smith’s terms, “machines”), which tend to increase the capital intensity of the task (WN, I, i, 8; cf. Persson and Sharp [2015, 30] and WN II, introduction, where Smith argues that more stock is needed as division of labour increases because more material has to change hands and be financed in advance, cf. WN, II, iii, 32). The third channel is a consequence of the societal division of labour (Elmslie 1994b, 654–55), which leads to the emergence of “philosophers”, who can more systematically analyse processes, products and abstract problems, and can thus produce more path-breaking innovations (WN I, i, 9). There are thus micro (individual-level), meso (occupational level) and macro (societal level) cumulative circles from division of labour to technological progress (and thus ultimately economic growth).3

In a simple extension of Smith’s ideas, it would be easy to imagine that the social division of labour might intersect with the occupational division of labour and lead to “specialized philosophers”, i.e., scientists specialized in different areas, as indeed emerged from the nineteenth century. If such an occupational circle of technological progress is localized in space, a model of geographical (or territorial) division of innovation and production (in clusters) would be the result, leading to relative specializations of different regions and countries, highlighting the importance of tacit learning through personal interaction.4 Elmslie and Jones (1993, 72–74; following Bloomfield [1975] 1994, 112), for example, relate Smithian division of labour to

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2 Such “philosophers” can only emerge and develop if the social division of labour allows them to be “unproductive” in commodity production and distinct from other “unproductive” workers such as sovereigns, judges and soldiers (WN, II, iii, 2–3).

3 Elmslie and Jones (1993, 70) refer to a section from the Early Draft of WN to highlight this cumulative feedback from division of labour to trade and from trade to division of labour (see also WN I, i, 11; I, iii).

4 Elmslie (1994b, 656–61) discusses the international implications of Smith’s explanations in book I, but focuses on international technology transfer through trade rather than specialization, and thus more similar structures of production between countries and less of basis for trade (see also Schumacher 2018). However, technology transfer needs capable philosophers in both countries, so that countries without philosophers could benefit from trade only because it enables them to sell surplus production in agricultural goods against manufactured products from countries with philosophers (for details see the following paragraphs, cf. de Blecker [1997] and Elmslie and Jones [1993, 58–69]). However, Elmslie and Jones (1993, 70) highlight [see footnote 5] the cumulative circle between deepening division of labour and more trade in Smith’s Early Draft, which – if it applied beyond national borders – would hint at relative specialization rather than imitation even between countries.
economies of scale in Krugman’s new economic geography models – which model exactly the sort of economies of agglomeration in space “reconstructed” above – and therefore argue for the emergence of a territorial division of labour in the process, although it remains indeterminate (subject to historical chance) which activities locate where.\(^5\)

The literature is, however, sceptical as to whether such a “rational reconstruction” of Smith’s theory can be reconciled with the actual content of WN (see especially Schumacher 2018 and the references given there). This is because the account of the division of labour outlined in book I almost completely disappears until the more policy-oriented sections in book IV, and instead Smith introduces in chapter i of book III a “natural order of opulence”, which starts with agriculture, then moves on to manufacturing and finally to domestic and foreign trade (Schumacher 2016, 2018; Tribe 2006, 64–66; see WN II, v, 11–36, and especially III, i). This order has been presented in the recent literature as the essence of Smith’s theory of economic development, and seems to be, at least at first sight, at odds with what he writes on the beneficial effects of the division of labour (Blecker 1997, 531–32; Schumacher 2018).

The main argument here refers to the origin of “opulence” or wealth, which according to Smith can be found in labour, which becomes more efficient through capital accumulation (WN, II, iii, 12). Since capital is subject to declining profits from its increased employment, which leads to more production and stronger competition, it is constantly searching for more productive employments (Schumacher 2016, 776–77; WN II, iii, esp. 38) once production and competition in the original sector enters a stationary state. Capital, originally, is more productive in agriculture, since here in the natural state only the remuneration of wages (or the opportunity cost of self-cultivation) has to be deducted from the obtained prices for the calculation of profits, since production is for subsistence and there are no landlords (Schumacher 2016, 778–79; WN II, ii, 25, 29). This is because agriculture, providing food, does not require that the purchase of inputs

\(^5\) Note that Bloomfield ([1975] 1994, 112), seems to be arguing for economies of scale without a geographical component. Cf. Elmslie and Jones (1993, 74), who argue that before Krugman’s time (up to the 1970s) economists probably lacked the modelling skills to combine both.
be financed before production can take place (which binds capital and is presented as a sort of transaction cost in WN II, intro, 3; II, i, 4).

Once the capital employment ceiling has been hit in agriculture, a first level of specialization emerges, for example between farmers and the producers of investment and consumption goods for agriculture (e.g., tools and clothing). Thus a manufacturing sector is established, and is eventually brought to a stationary state as well (see WN, III, ii, 20). At this point, transaction costs occur, because goods have to be brought to the market and because production has to take place before sale/exchange, so “stock” has to be piled up and production financed in advance. But, nevertheless, the work of those involved in transport and trading are considered as “productive labour” that enter the value of the goods in the supply chain (WN, II, v, 1–8, 10a, also III, i, 1, IV, ix, 11). This illustrates why division of labour requires prior capital accumulation, but is not the original reason for this. Domestic (local retail) trade here emerges as an employment for further surplus capital, and at the same time allows the emergence and growth of surplus production, as consumers and investors emerge who want to enjoy a share of these surpluses (WN, II, v, 10a–11).

From this we can see that, for producers and consumers, trade, and the cost component added by merchants and shippers, should be avoided in general, since it involves costs from the division of labour as consumers and producers are both functionally and geographically disintegrated (cf. North 1984, 7; Elmslie 2018; WN II, i, 1, see also I, i, 3–4). Trade over larger distances should therefore, in particular but not only in the early stages of “opulence”, be an exception rather than the rule, and foreign trade should only take place if all better employments of capital have exhausted their possibilities – it is thus a consequence and not a driver of development (Schumacher 2018). Exceptions would be trade in commodities where price differences can bear the cost/value added by merchants and transport (such as luxuries and “more sophisticated manufactured commodities”, Schumacher 2018, 12).

6 With this, to borrow from North (1984, 7), the “costs of trade, […] the losses that arise because of specialization and division of labor” can easily be understood.

7 In addition, Smith expects trade to be more beneficial for the economy if it consists of investment goods rather than luxuries (WN, II, iii, 33–36), since the latter have basically no domestic employment effects, and the use of labour is, as mentioned at the start of the preceding paragraph, the main
Examples of such trade would include that where the prices of commodities in different places are enormous due to differences in geographical conditions or cost of living resulting from differences in the stages of development. The obvious example of the first is Smith’s discussion of quality wine production in Scotland (see WN IV, ii, 15; cf. Bloomfield [1975] 1994, 112–13; Rassekh 2015, 75). The main, and much discussed, case of the second is trade in agricultural goods, as the result of uneven economic development in space. This will lead to lower wages and hence costs in agriculture in “less developed” countries (those still in the agricultural stage of development) and these form the basis of price differences that make trade with more advanced countries possible (Elmslie and Jones 1993; Elmslie 1994a, 1994b, 651–52, 656; Blecker 1997; Schumacher 2018), although the high incidence of transport costs on the price of agricultural products limits this possibility in practice (Schumacher 2018; WN IV, ii, 17 on the effect on prices for Irish cattle in the UK). This will, however, be unlikely to form the basis of or even an element in a Smithian theory of development, since it would be harmful if these countries used their own capital in trade (Schumacher 2018), and it would only make sense if capital from developed countries would be employed in it, as Smith highlights when he states that agriculture in the British North American colonies was progressing very fast because even retail trade was made with foreign (British) capital (Schumacher 2018; WN II, v, 21, III, i, 4–7). Moreover, in the extreme case, such trade might lock countries into the agricultural stage of development and thus hinder their advancement to the next stage and perpetuate their underdevelopment (Schumacher 2016, 781).

Thus, in this interpretation of Smith, division of labour seems to happen, and might have beneficial effects, but it is much less clear that he considers it to be the main driver of growth: rather it is simply one of the mechanisms through which capital accumulation plays out. Foreign trade seems to play an even smaller role in this story, at least if one follows the interpretation by Schumacher (2018, 14) who argues that Smith simply does...
not understand foreign trade in terms of international division of labour. Bloomfield ([1975] 1994, 123) also argues that the “narrowness of the home market does not hinder the division of labour in any particular branch of art or manufacture from being carried to the highest perfection” (referring to WN IV, i, 31). In this view, consistent with Smith’s critique of mercantilism, foreign trade might even be potentially harmful if engaged in too much, since capital should be employed elsewhere first. Favouring merchants, shipping and carrying trade instead of domestic agriculture and manufacturing (Bloomfield [1975] 1994, 129–30) would lead to “unnatural trade” (see Tribe 2006, 75). Almost all foreign trade that is described as more or less “natural”, i.e., based on differences in prices, would even partly make itself redundant if merchants instead employ their capital more profitably in import-substituting production at home, enabled through technology transfer and reverse engineering (Schumacher 2016, 775–76; Schumacher 2018, referring to WN III, iii, 19) leaving only special cases such as wine-growing in Scotland.

On the other hand, one might establish a different balance between the division of labour and the “natural order of opulence” as proposed by Blecker (1997). He argues that Smith himself states that the natural order is seldom observed and contrasts with actual European history since the fall of the Roman Empire, which features all sorts of “unnatural” elements. At the centre is a narrative of the emergence of powerful (warlord) landlords and cities of non-agricultural producers and markets privileged by

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8 Schumacher (2018, 14): “As different regions in a country produce both agricultural and manufactured commodities, so will countries in the world market. No country would specialize solely in agricultural goods and no country would specialize solely in manufacturing”. Of course, specialization never has to be complete, either at the level of the individual (even the people employed in the pin factory would engage in non-market production outside their working day), or at the regional or country level – since there are always transport and transaction costs.

9 Here, an example of what Smith might refer to as “unnatural” attempts to foment trade (Treue 1962, 277–78) might for example be the Russian shipping regulations introduced in the late 1780s to decrease the shipping revenues of British merchants and shippers in favour of Russian agents, with the aim of creating a balance of payments more favourable to the Russian Empire. According to Treue, because there was no sufficient domestic talent and capital available to step in, one of the consequences was the Russification of some English merchants, but this had little effect on an economy which otherwise was very agrarian (under feudalist production regimes), had most of its limited manufacturing in the countryside (on the estates of feudalist landowners) and lacked towns and an urban culture comparable to Western Europe (Treue 1962, 274, 279).

10 This would be difficult for countries in the agricultural stage of development due to a lack of basic capabilities in manufacturing (Elmslie 1994b, 656–61; Schumacher 2018, 13), an argument which again could be extended to mean that trade would not be helpful for the development of poor countries.
monarchs to counter their power and influence (cf. Tribe 2006, 67, 70). This process eventually leads to the demise of feudalism and an increasing political and economic weight of the agents in the cities, especially merchants, accompanied by continued support for them from monarchs through mercantilist policies and regulations favourable to international trading and shipping (WN III, ii–iii). While Smith argues against such privileges, one might understand his insistence on the division of labour in book I as a way to make sense of the central role of the extension of markets that started with the beneficial effects of towns on the surrounding countryside (see WN II, iii) for European economic development, combined with the questionable role of mercantilist policies in distorting a natural process following from this, or from the original order of opulence.

Although the debate about the role of the division of labour and international markets in Adam Smith’s work on economic development will no doubt continue, we believe that our case study offers an, admittedly “experimental”, way forward towards settling its historical relevance. As we touched on above and discuss in the next section, it was only some years after the death of Adam Smith that Europe came closer to the conditions for “natural” Smithian development, especially regarding the role of division of labour and capital investments in agriculture, as well as in terms of the transition from agriculture to manufacturing. It was therefore only then that it is possible to examine how the different processes that Smith analysed interacted in practice.

3. A framework for understanding Smithian growth: integrating the history of economic thought with economic history

When Adam Smith wrote WN, the division of labour and the extent of the market were relatively small in comparison to what was to come, although domestic markets in Britain, even for agricultural products, were rather well integrated already by 1700 (Campbell and Ó Grada 2011; Chilosi et al 2013; Clark 2015). Indeed, at the end of the eighteenth century all countries were relatively poor by today’s standards, and even by the standard of one hundred years later, and the costs of bringing goods to distant markets were much higher and involved large amounts of scarce capital. Foreign trade
was even more risky than domestic trade, both due to institutional (property rights and their enforcement, mercantilist restrictions on market access) and technological costs, distortions and uncertainties (WN I.iii; III, i, 3; cf. Ruffin 1974, 261). This might have affected Smith’s argumentation in ways that inform the interpretations given in the previous section that argue that in his view the division of labour did not extend beyond the national level, although here his empirical context rather than genuine economic thinking might have been the basis of his observations. Thus, it might have been as difficult for Smith to abstract from observed technological and institutional barriers to trade, including mercantilist distortions, as it would be for any writer on economic development to describe the state when an economy, or even a sector, is “fully developed”.

Thus, whether or not the country is the relevant unit of observation of economic development when applying Smithian thinking, and whether therefore international trade is fundamentally different from domestic trade in his framework (as argued by Schumacher 2018) or a natural extension of it,11 can thus also implicitly be tested by looking at what producers do when the cost components separating producers and consumers decline as geographical barriers are removed, and the international environment is corrected towards Smith’s natural order by dismantling mercantilist barriers and privileges. We argue that the appropriate testing ground for this, at least in Europe, is the nineteenth century, which saw a massive amount of market integration which accompanied the appearance of new goods and improvements in production. We narrow this down to the case of Denmark, and the development of agricultural production in this process. We attempt to employ a micro-view, that is, one focused on agricultural producers and their view of the process, and thereby deepen and extend Smith’s case study method back into agriculture.

The classical economic history literature (conveniently summarized in Treue [1962, 303–20])12 describes Denmark up to the 1780s as a national economy with all the elements of “unnatural” distortions present in Smith’s historical account, in an even more

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11 See Elmslie (2018) for border regions based on WN IV, iii, c.12, and Elmslie (1994b, 650–51) for a general formulation. For the whole discussion see also Tribe (2006, 72–74) and Schumacher (2018).
“unnatural” mix than that present in Britain by 1776. The influence of aristocratic landowners on central government and in agricultural production increased into the 1760s and led to ever tighter labour regimes in the countryside (see for example Jensen, Radu, et al. 2018), and this was curiously accompanied by mercantilist policies, such as a prohibition on the import of manufactures to protect Copenhagen as a market place (until 1730) and domestic production in order to create employment and improve the balance of trade. The basis for the growth of the Danish merchant fleet – privileges in the Netherlands – are literally described as “unnatural” (Treue 1962, 317). This “unnatural” developmental policy mix was judged as a failure mostly due to general capital scarcity in Denmark and the channelling of much of the little available capital into unprofitable privileged manufactures. It was abandoned in the 1780s as “physiocratic-liberal reforms put agriculture in the centre”, thus leading to a policy turn that established over the following three decades a laboratory for Smithian growth under much more “natural” conditions.

Thus, the period between the 1760s and the early 1800s witnessed greater mobility as peasant bondage to estates was dissolved; a system based predominantly on leasehold for most farmers was converted into one of freehold with full-property rights; and as peasants also largely freed themselves of labour services to be performed on the demesne as part of rent payments under the traditional system of production and social order. At the level of the government, estate owners were stripped of their traditional functions as public administrators, tax collectors, military recruiters, and appointees of local judges, teachers and priests. Thus, the centralization of government converted the (mostly noble) estate owners from “local vice-regents”¹³ into large landowners. This period also witnessed economic changes in the countryside, as the large estates introduced new crop rotation systems, which they combined with more labour intensive animal husbandry in order to produce manure and to diversify production (see Jensen, Lampe et al. 2018), probably as a reaction to demographic growth and an ecological crisis in the first half of the eighteenth century (Kjærgaard 1994, 159–61), similar to that described below as a central set of incentives for agricultural investments in Smith’s account. These improvements were part of a process of bourgeoisification of the large

¹³ Kjærgaard (1994, 205), citing Jensen (1936, 16).
landowners: traditional, quasi-public manors were converted into private villas, the aristocratic style of living receded and estates were transformed into large commercial enterprises. Many landowners converted themselves from public figures involved in politics into something more like private businessmen (Kjærgaard 1994, 231–35), or they were replaced by a new class of merchant-farmers on their estates. Large estates evolved into centres of commercial agriculture and thus became the sort of places where new crop rotations and management techniques could be tested and put into practice both by enterprising landowners themselves, or by “professional” administrators or tenants (Bayly 2004, 427; Schiller 2003, 64, 477–95, 504; Mokyr 2009, 183, 191–92). From the 1780s, as the former tenant farms acquired full property rights, a simultaneous enclosure movement took hold, leading to a completely new settlement pattern in most villages as farmers moved out of villages into farmsteads on their newly consolidated holdings. This change from communal systems of open-field cultivation gave a newly emerging freehold farmer class new freedoms and responsibilities to decide on their own cultivation systems, crop rotations and improvements.

The late eighteenth and early nineteenth century also saw the rise of the market economy at both the national and international level. In the nineteenth century, probably the major challenge in a country as small as Denmark was how to integrate agricultural producers, large and small, into international markets. Before the major disruption of the Napoleonic Wars, incipient international market integration had taken place in north-western Europe (Lampe and Sharp 2015a), but had probably not yet induced profound productive specialization. After 1815, widespread agricultural protection limited this integration process until the 1840s, when the British Corn Laws and many other barriers to international trade in agricultural produce fell (Federico 2012). Thus, from the 1840s there was a sustained increase in agricultural imports in countries increasingly specializing in the production of manufactures (such as Britain) and a corresponding increase in agricultural exports from countries like Denmark, Sweden and Prussia. The resultant market integration was reflected by an increase in the co-movement of prices at the international level, as domestic prices began to reflect less domestic supply and demand, and more world economic conditions (Uebele 2011).
This process could be observed both in the latter decades of the eighteenth century, and, after widespread agricultural crisis in the 1810s and 1820s, again from the 1830s, which is the period we focus on in the present paper, since it is much better documented. Smith provides the basic framework for understanding what agricultural producers do in this context. He explains that a producer knows about the natural price of the commodities he produces, which is just the cost of labour and the remuneration for profits on capital (plus land rent). What he eventually receives, however, is the market price at the intersection of supply and demand. Since producers and consumers react to price signals by increasing competition, the market price and natural prices should in the long run be co-integrated (WN I, vii, 15).14

Given this, understanding how producers understand and organize their side of the market is relatively straightforward for Smith: they pick up price signals from the market. In book I, xi, Smith presents a digression on the long-run evolution of the price of silver (or, in effect, general inflation, as silver was the main specie) which includes a discussion of how improvements led to falling prices. Here, he discusses improvements in agriculture (see all of I.xi.I), and specifically (I.xi.I, 8) what drives farmers to increase the production of feed for animals to produce meat (here: poultry): “For some time before this practice becomes general the scarcity must necessarily raise the price. After it has become general, new methods of feeding are commonly fallen upon, which enable the farmer to raise upon the same quantity of ground a much greater sort of animal food. The plenty not only obliges him to sell cheaper, but in consequence of these improvements he can afford to sell cheaper, for if he could not afford it, the plenty would not be of long continuance”. In other words, agents react to market signals, but by their reaction they run the risk of cancelling out the initial incentive and ruining their investment. Thus, in the long run, they need to do not just more of the same, but to improve, and fortunately this – learning by doing – is the main consequence of specialization for producers (see for the general case, I.i.5). Implicit in this and other sections of WN is that competition is what links increases in production to increases in

14 But remember that only producers who market the goods themselves get the price the consumer or investor pays. In all other cases the price is the sum of the natural prices of all stages of production, including transport and marketing (Schumacher 2012, 2018, e.g., WN I, vi; III, I, 1) – this means that if markets are involved there is always a value chain and individual producers do not produce the supply to consumers “alone”. 

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efficiency. In relation to that, in l.xi.l.9–11 Smith presents hog-raising essentially as a by-product of dairying, and explains that its price rises with increasing demand, as the latter eventually requires dedicating land to produce hog feed. He continues to explain that in his time in England pork was more expensive than beef because the number of cottagers had greatly diminished (presumably due to the enclosures), and hence family producers who raised hogs as a side-activity were scarce. Again, there is a role for markets here, and improvements can be understood as more capital intensive and more efficient production, although it does not seem that division of labour plays an important role.

At the macro-level, a similar pattern can be empirically described for Danish agriculture. Figure 1 describes the movements and the general trend of grain in comparison to animal prices in England from 1818–1900, and moreover it can be shown that market prices for individual goods were integrated between Britain and Denmark (Lampe and Sharp 2015a). What is visible is a constant upward trend in the relative prices of animal products, which, however is only clearly discernible from the 1850s, after the repeal of the British Corn Laws. Figure 2 shows how Danish agriculture reacted to these price signals: the share of animal products in gross output is rather flat until the 1850s, and from about 1857 starts a steady increase, in which animal output became more and more important.
This reflects the well-known rise of the Danish dairy industry that not only supplied Danish cities, but also British workers with butter, bacon (made from pork raised on waste products from butter production) and eggs (from hens fed with the by-products of butter and bacon production). All these processes did not mean abandoning grain, but actually went along with intensifying it to generate more and more animal feed, although in later stages imports of additional feed and fertilizer became important.

This development is normally framed as a part of the first globalization, in which international markets integrated and producers reacted to this, but this story is well-known (Kindleberger 1951; Henriksen 1993). In the following, we focus on understanding how Danish producers actually shaped this process: large Danish landowners noted rapidly the opportunity to increase sales of agricultural products abroad, although it was less evident whether these should be barley\(^{15}\) or other grains; the products of animal husbandry, such as for example live cattle, whose exports had a century-long history but were experiencing decline over preceding decades (Appel and Bredkjær 1924–32, 250–69; Hünniger 2010, 79; Drejer 1925–33, 158–63), or wool; or processed products such as butter, for which the neighbouring Duchies of Schleswig and Holstein were acquiring a reputation on the British market, or cheese. We are particularly interested in how they decided on specific investments in and reorientations of the production process, and how these decisions interacted with an orientation of the product mix and purchase of inputs, for agriculture and from manufacturing, that naturally would increase the capital intensity of production, and how they were justified. In passing, we also investigate whether international markets and merchants played a role in this. We thus try to open up the “black box” of the invisible hand and integrate it with the “visible hand” of estate management to understand how individual decisions interacted with and eventually benefitted larger segments of the economy and society in Denmark and potentially also abroad.

In this, we borrow a method from the field of accounting history, although we by and large abstract from the material insights that field provides for the purposes of this paper. Specifically, we use our case of Danish estate owners, administrators and farmers, to trace their cognitive framework in the way that Bryer uses this, based on

\(^{15}\) Denmark’s main export product in the early nineteenth century and up to the 1860s (see Lampe and Sharp 2011).
Karl Marx’s account of profits in different stages of history, to examine whether they thought in a feudalist, “capitalistic” (semi-capitalist) or capitalist manner.\textsuperscript{16} We do not follow Bryer here on his line of argument, but would like to underline that the history of especially Marx’s thinking would benefit from engaging with accounting history in this way.

Although we use bookkeeping to understand how Danish producers acted in a Smithian framework, we do not argue that Adam Smith would have used this method or have recommended bookkeeping as the basis of scholarship. He himself was highly sceptical of Petty’s macro-measurement attempts at “Political Arithmetick”\textsuperscript{17} and might be expected to have held similar views on micro-measurement. Bryer (2013, 576–79) expresses clear scepticism of Smith’s understanding of capital, profits, etc., in the sense that capitalist and modern accounting understands these terms. Both aspects might have obscured Smith’s thinking about the details of the components of a “natural price”, and thus also the systematic details of production costs, so that instead of using systematic comparisons like those we outline in our analysis below, he invented a different, “let’s suppose” case study approach (WN, I, vi, 6), which incidentally became influential in jurisprudence in the United States in the early nineteenth century.\textsuperscript{18}

4. Opening up the black box of Smithian growth in Danish agriculture
As we noted above, the period of history we describe here was characterized by a number of aspects Smith would have described as unnatural, both in Denmark and

\textsuperscript{16} In hugely simplified terms, Bryer argues that imposition of accounting might have been for the sake of class interests and profit maximization and the appropriation of surplus generated by labour (see Bryer 2000a, 2004, 2006a, 2006b, 2017). A third school denies the primacy of economic forces, and argues that cost accounting was introduced to discipline workers and managers so that they became “responsible” (Hoskin and Macve 1994).

\textsuperscript{17} And thereby contributed to systematic quantitative empirical enquiries maintaining only a secondary role in the evolving discipline of economics well into the nineteenth century (Backhouse 2002, 72)

\textsuperscript{18} We owe these points to Peter Aschenbrenner (personal communication, July 27, 2018, and August 14, 2018), who is preparing several papers on the reception of Adam Smith in legislation and jurisprudence we are much looking forward to. As Aschenbrenner also highlights, systematic comparisons presuppose the widespread and comparable use of (cost) accounting. Elmslie and Jones (1993, 74) make a similar argument in the context of understanding Smith on trade, that before Krugman’s time (up to the 1970s) economists probably lacked modelling skills to combine increasing returns to scale and the division of labour due to lack of modelling devices in economics until when Krugman established New Economic Geography. Cf. Bloomfield ([1975] 1994, 112).
elsewhere in Europe, although Danish serfdom was abolished in 1800, and mercantilist policies were scaled back already in the first half of the nineteenth century. Protectionist barriers to trade in favour of dairying continued throughout the century, however, and might have played some role for allowing early cooperatives to be profitable (Henriksen et al 2012). It was within this context that the large landowners we discussed in section 3 entered the picture, introducing new agricultural techniques from the 1700s, with a second wave arriving after the crisis initiated by the Napoleonic Wars.

This new generation are in the traditional historiography somewhat embodied by the person of Edward Tesdorpf, the son of a Hamburg merchant, who purchased the Orupgaard estate on the island of Falster, south of Copenhagen, in 1840. He later became president of the Danish Royal Agricultural Society, and received praise for his contributions in everything from agricultural science to organizing trading links with the UK (Lampe and Sharp 2015a, 449). We look for evidence of how farmers used accounts to make decisions in a series of publications, starting with Tesdorpf, who was an early proponent of accounting as a means of promoting production decisions.19 In this way we trace the origin of Smithian specialized “philosophers” within agriculture, how they attempted to understand the changing and uncertain world within which they operated, and how the knowledge they gleaned from their accounts allowed them to specialize effectively, at first focused largely on maximizing profits at home, and later abroad. The knowledge they generated, by allowing for effective specialization which they promoted to a wider and wider field of farmers, then in turn, as Smith predicted, led to the massive productivity increases which characterize the development of Danish agriculture at this time. This is truly the invisible hand in action, and we can, as it were, observe its operation through the discussions in the scientific literature.

That we have such a wealth of information for Denmark owes much to earlier developments as enlightenment thought spread to the country in the eighteenth century, in part through the large landowners, when scientific societies were established together with a vibrant scientific press. For agriculture this was most importantly the two journals TfL and UfL, and it is largely these which we turn to in order to trace the origins of accounting as a central statistical tool, with a seminal contribution being an

19 For a fuller account please see Lampe and Sharp (2019, ch. 5).
article reporting a speech by Tesdorpf at the annual meeting of the Maribo (Agricultural) Economic Society in 1856. In this he underlined, using data from his dairies, that early calving and feeding of cows through the winter – an innovation in terms of the natural breeding cycle of cattle – was profitable in part through the production of pork as a by-product (as Smith himself had also reflected on).20 This speech was published by the editors of UfL, who invited others to provide “similar valuable communications” (Tesdaorpf 1856, 85), leading first to a reaction by another estate owner, Adolph Valentiner (1856), who published some results of his dairy and comprehensive comments. Tesdorpf then provided some of the in-depth information requested by the editors of UfL, first with an article by his administrator, Buus (1858), who reported detailed information on Tesdorpf’s estate Gedsergaard for 1857–58. Tesdorpf (1861) himself then extended these to the production year 1859/60 for Gedsergaard and his main estate, Orupgaard, both situated on the island of Falster.21

It was TfL, however, and a couple of contributions by Frederik Sehested (1857, 1858), which took the discussion to a different level of exposition. Sehested incorporated majestic tables that contributed two new insights: first, an exposition tracing the use of all the milk given by the c. 125 cows on his estate, Stamhuset Broholm near Svendborg on Funen, for 1856 and 1857, into all the direct uses on the farm through human consumption, feeding of animals and the production of butter, milk and cheese that were consumed and sold.22 His motivation for so doing was stated clearly. His accounts gave “rise to various questions and give the possibility of various alternative configurations, in addition to those which are needed in order to make the following comparisons... This remark does not preclude the opinion that the accounts in several ways could have been better” (Sehested 1857, 143). He in this way describes the role

20 In different contributions, Tesdorpf also contributed to a debate which had been emerging before 1860, as the relative prices of dairy products and bacon rose relative to that of wool, concerning whether to keep sheep or cows, and concluding in favour of the latter (Larsen 1924–32, 611–14) – an important first step on the road towards specialization in dairying. To keep the present article focused, we have to exclude such further strands of inquiry.

21 Much of the information on physical outputs from the 1840s for Tesdorpf’s estates, especially Orupgård, is preserved in the regional archive for Zealand and surroundings, in part in handy time series (Landsarkivet for Sjælland m.m., QA-257 Orupgård Gods, Statistik over høst, mejeridrift og færehold 1849–1904), where also further accounting documents for those estates and some others have been preserved.

22 The handwritten manuscript versions of these tables are also preserved in the Danish National Archives (Landsarkivet for Fyn, QB012, Stamhuset Broholm, 18/267, Diverse Mejeriregnskaber mv 1816–1887).
which he believed accounting could play: his accounts could answer concrete questions, and they could also give rise to new ones. More importantly, however, accounting provided a flexible framework that could shed light on a multitude of other issues. Some detail will serve to illustrate the precocity of his work. Thus, in 1856, Sehested states that of 95,542 cans (of 1.92 liters) each of milk given by the cows, only 6,818 (7 per cent) were consumed directly in the manorial household and by calves that were fattened for slaughtering and those raised as future cows in production. The rest was skimmed of its cream, which was consumed directly in the household and by animals (586.25 cans) and converted into 10,352 pund (of 0.5 kg) of butter, partially consumed in the household and by animals (23 per cent) and mainly sold on the market at a price of 0.41 Rigsdaler per pund. The volume of the butter accounted for 3,268 cans, or 3.4 per cent of the volume of milk produced. Therefore, in the process of skimming, 84,870 cans of liquid must have remained. 7,084 of them were buttermilk, left over after churning the cream into butter and fed to pigs. Logically, the rest must have been skim milk, although Sehested could only directly account for 74,354 of the theoretical 77,786 cans: 2,523 cans were used in the manorial household, 156 were given as donations, 558 were used in the manor’s brick factory, 2,310 were given to calves to be used as future milk cows, 7,694 went to pigs, and 11,135 went to other animals. 46,955.5 cans were used for making (skim milk) cheese, leaving 38,833 cans of whey, which were again fed to the pigs. The “missing” 10,516 cans of liquid entered his accounts as milk evaporated while waiting for the cream to separate before skimming, as a standard share of 4 per cent (3,549 cans) and as ‘other (of which no account can be given)’ (6,967 cans), and for which he gives a long footnote with potential explanations, and whose share in total liquid he managed to bring down from 7.3 per cent in 1856 to 5.2 per cent in 1857 (Sehested 1858).

Sehested also provided a handy summary for the reader that omits some of the production concepts and focuses on the main products of the farm: of the volume contained in 100 cans of milk, 3 per cent were embodied in butter; 9 per cent in skim-milk cheese; 9 per cent in buttermilk and 75 per cent in whey (both fed to pigs); and the remaining 4 per cent had evaporated. Since he knew the average values of the products sold (minus additional inputs used in pig feeding), he could calculate that 100 cans of milk brought him on average 7.73 Rigsdaler, of which 5.08 came from butter, 1.68 from
skim milk cheese and 0.97 from the buttermilk and whey fed to pigs. He also calculates the value of the 16 calves that he fattened and sold alive and slaughtered in order to calculate the value of the 3,063 cans of full milk invested into cattle fattening, arriving at a value of 0.047 per can of milk, significantly lower than the value obtained in dairying. His main interest was to use his accounts to assess the effect of feeding concentrates on the milk and butter output of his cows as part of a wider discussion on “strong feeding”, that is, the use of grains (mainly barley), oilcakes, etc., to improve milk yields, and the production of pork as a by-product, mainly through the improvement of the cows’ nutrition over the part of the year when outdoor grazing was not possible. To do this, he used the total values of income produced and deducted from his actual expenses for wages, energy and basic wear and tear, and calculatory expenses for feedstuffs he produced himself (Sehested 1857, pp. 131–33). This led him to a “net earnings” figure, which he relates to the amount of land used by the cows for grazing in summer tønde land (0.55 ha), which can be understood as the land’s contribution to production or the cows’ contribution to the maintenance of the fertility of the grasslands as manure. Hence the “net earnings” could also be calculated per cow, as the “fertilizer-value of the cow”. This way of calculating implies that minimizing the deficit (and the manure price) of the cow could be achieved by maximizing the value of other outputs of cows, on which the subsequent discussion is centred. The ultimate question was hence whether the additional cost of concentrates would lead to an at least equal increase in the output values of cows, thereby producing manure at lower costs. This logically required comparison to understand how additional feed translated into higher output and hence larger revenue – a question where comparative accounting could solve questions that chemists were struggling to solve convincingly (Depecker and Vatin 2016).

Sehested’s contributions and considerations can be seen to lay the groundwork for much of the developments that were to follow. In Smithian terms, through his own self-interest and by seeking to increase the profitability of his farm, and to learn from others, he impacted more widely on society, not least through the crucial innovation of accounting in agriculture. Indeed, the uptake by other farmers was rapid. His contribution led to a reply by Valentiner (1858), who praised his way of obtaining calculatory values for products whose prices could not be observed, but criticized Sehested’s principal interest in quantities of output. He argued that Danish farmers
should not forget that, apart from maximizing total production, they would also need to be able to sell their produce at the best possible price – an important consideration not only from the perspective of its movement towards what modern economists would stylize as profit maximizing behaviour, but also a necessary step towards allowing the wider industry to specialize effectively, given the changes in relative prices documented in figure 1. Thus, he writes that “monetary return is the final and only result that can reveal a farmer’s profitability. We farmers have the task of first producing the greatest possible amount of the raw material, then making it into the best possible commercial product, and finally to sell this product in the best way possible; the man who does this best is the best farmer” (Valentiner 1858, 349). In UfL, an anonymous contributor “m-e-“ (1859) also provided some additional calculations in order to “prove a discussion” on how to value milk via its marketable products. Thus, the final link in the accounting chain was made clear: Sehested had argued that accounting was necessary for decision making (largely about what to feed the cows, but arguing for more general interest); Valentiner made it clear what decision needed to be prioritized, profit (“monetary return”), although the calculation of this was only weakly understood at this time.23 Thus, responding to Sehested’s request for others to submit their accounts, his contributions were followed by many more, in part to provide comparisons, although most of these do not allow for the detailed assessments pioneered by Sehested. Some of these contributions, however, contained figures reaching back into the 1840s, illustrating that records had been kept before and signalling participation in the emerging “accounting movement” by a range of actors, an early example of which was posthumously provided by the forester Bjørnsen (1857, 1859), published by the editor because he believed it demonstrated “how large a return a small dairy can give if it is managed with expertise and skill”. Then, just one year later, the estate owner and politician Jørgen Henrik Theodor Hasle reacted to several accounts published in both TfL and UfL, “which more than I have read with great interest”. He requested permission to present the accounts in UfL from the Rosenlund estate on the island of Lolland, where

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23 In doing so, he re-invoked a program laid out half a century earlier by Carl Frederik Gyllembourg, which had not been immediately successful in times of crisis (Lampe and Sharp 2017). The difference this time was, however, that the arguments had tremendous traction.
he considered the tenant farmer to be particularly successful, and thus “it would please many to a see an excerpt of his dairy accounts published” (Hasle 1858, 585).

Of particular interest for revealing the link between dairying and science are a couple of articles published in TjF by Peter Berend Feilberg (1835–1925) who was (together with two others) the first to complete a two year education in agriculture and engineering at the College of Advanced Technology in Copenhagen (now the Technical University of Denmark), which he followed with practical experience in Holstein, later becoming an expert in the drainage and cultivation of lakes (Pedersen 1979–84). Feilberg provided eloquent statements of the emerging paradigm, writing in his first contribution that one should strive to “oppose damaging effects, to detect and correct mistakes, to record a simple new idea, and that the truth and interest in it that is awoken is in and of itself rich dividends” (Feilberg 1861, 321). Then, in his second article he noted that it is difficult to compare different dairy farms without “detailed accounts”, and that it is “not enough that the farmer carefully notes how much butter and cheese that is sold; he ought also to demonstrate a similar accuracy in the entry of the material of which the sold items are produced, and what otherwise might have an influence on production. Praxis would then lay a foundation on which theory could be built, in that it would be possible through the volume of special observations to display ordinary experiences, link them to science, and thus find teachings, the application of which could be advantageous and successful in the practical life” (Feilberg 1862, 263). In a similar vein, Baron Zytphen-Adeler (1863), who had acquired his title by converting his lands around the medieval castle of Dragsholm into an entailed estate in 1843, explicitly stated that he hoped that by publishing his accounts others would find something they might wish to imitate, and that this might inspire them to publish “which daily procedures and accounting they use, and thus by comparison obtain a better result” (Zytphen-Adeler 1863, 377).

Alongside this, over the 1860s, Tesdorpf (1861, 1867, 1868, 1871), who was by then president of the Danish Royal Agricultural Society, continued to report and interpret data from mainly Orupgaard and Gedsergaard, going back to the early 1850s. Using this, 24 In later justifications of what was to emerge from this process as the “modern training of agronomists”, he was named by Segelcke (1867, 8), alongside Buus and two others, as an outstanding example of the benefit to be expected from such training, in defense against traditionalist critiques.
his administrators advanced the discussion in key articles motivating economic decisions, especially regarding the relative productivity of milk/butter production and cattle fattening/beef production in those years – Smithian specialization in action. Thus, Buus (1866) contrasted two 100-animal herds specialized in dairying and beef production, modelled on Tesdorpf’s estates Gedsergaard and Frisenfeldt, respectively, and making various improvements to Sehested’s early methodology, including “amortization” of 6 per cent per year on the inventory (instead of basic wear and tear), including stables for pigs and dairy equipment, and calculating an annualized value of the grassland. He also assumed that dairy cows are only “in production” for ca. 4 years, so that each year “capital reinvestment” in cows had to be made to keep the herd size constant. Converting everything into fertilizer-value, he found that fertilizers from beef production were much more expensive than from dairy production. In 1873, Fenger (1873) returned to this issue, updating Buus’ data, but again confirming that, at least on Falster, beef production was much less cost effective than dairying.

In a contribution to UfL, Tesdorpf himself (1866) incorporated new circumstances into the framework pioneered by Sehested, this time discussing the outcomes of five years of experimenting with various types of fertilizers on his estates, especially Orupgaard, on the output of grain, which, used as feed, in turn led to higher milk and pork yields. He hence advocated the adoption of these new inputs. In the early 1870s, he (Tesdorpf 1874, 1875) used his accounts to examine the choice between the (then traditional) “bøtte” system for cream separation in butter making, whereby large shallow bowls were used, and the emerging water dairy system (later superseded by the cream separator), which allowed for the cooling of the milk and a more rapid separation of the cream in taller containers which took up less space. He found evidence clearly favouring the new system, which was more expensive but yielded higher net revenues.

At the same time as the circle of participants in the public discussions on accounting widened, Thomas Riise Segelcke was appointed as the first official dairy consultant to the Royal Danish Agricultural Society in 1860 – the first Smithian “philosopher” in Danish dairying as it were – after extensive studies in Denmark and around Europe, including a

25 Sehested had directly included the costs of feeding the calves to be used in production later on, apart from giving the newborn calves an initial value of 2 Rigsdaler.

26 Guano, and calcium phosphate from Chile saltpeter or crushed bones.
visit to the famous Rothamsted Experimental Station in the UK, and some practical experience in Denmark. He published a series of articles in TfL between 1862 and 1866, enthusiastically explaining how a scientific approach to dairying would lead to better quality butter (Bjørn 1982, 32). The most salient of these contributions is probably his 3. *meddelelse om Mejerivæsenet* ("Third communication on dairying"), published in 1865, in which he argued for a reform of work practice in dairying and in an article in UfL on “The education of young farmers, as it is now and as it ought to be”, provoked by a series of articles on the same topic. Segelcke railed against “tradition, the power of habit” and argues for the importance of a theoretical approach to agriculture, including the use of accounting, blank books for which he provided for his students (Segelcke 1867).

In his later lectures at the Agricultural College (Segelcke 1891), by which time such discussions were long-settled, he again highlighted the practical importance of pre-prepared blank accounting books for the ordinary farmer, which they simply had to fill in, especially the Prøvemælkningsbog ("Sample milking book") published in 1864 by Kammeraad Andersen, which contained one page for each cow per month (60). In close cooperation with other reformers, Segelcke published several of these blank books from the 1860s, for example Tesdorpf and Segelcke (1862), who reproduced weekly accounting tables used on Tesdorpf’s estates, and the Mejeridagbog ("Dairy Journal") and Mejeritavler ("Dairy Tables") he published jointly with Friis (Friis and Segelcke 1866, 1870–74), as well as Selgelcke’s *Mejerilærlingen* and *Optegnelsesbog*, a record book for dairy apprentices with introductory explanations (Segelcke 1872; Friis and Segelcke 1870). Other shorter versions were published by other authors (Segelcke 1891, 64–65), and we found many of these reviewed in UfL, alongside more extensive accounting guides.27

In 1874 Segelcke became the first permanent lecturer in dairying and agricultural accounting at the Royal Veterinary and Agricultural School in Frederiksberg, close to

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Copenhagen, which had been established by law in 1856 as a continuation and expansion of the Veterinary School created in 1773. In 1892 he was promoted to professor. Through his lectures, he was in a key position to spread the message of accounting and scientific decision-making to future generations of dairy managers as the sector grew quickly through the emergence of specialist creameries not just on the estates, but for a wider sector of the small- and medium-sized farms through the cooperative movement, at which point the specialization of the countryside was more or less complete (Bjørn 1982; Henriksen 1999). This focus on accounting also spread to other agricultural schools in the provinces, such as Ladelund, founded in 1879, with the first education for dairymen in Denmark established in 1887, when at first over 25 per cent of the teaching was devoted to accounting, although this fell to around 14 per cent in the early twentieth century (Bjørn 1982, 182–83). Moreover, under the guidance of Segelcke, the Danish Royal Agricultural Society’s new dairy consultant from 1886, Bernhard Bøggild, who became Segelcke’s successor as professor of dairying and agricultural accounting after his death in 1902, was to publish a series of books presenting the state of the art to cooperative farmers, including the importance of accounting (Bøggild 1886, 1887, 1889, 1891). These books were reissued several times until well into the First World War, with his advice regarding bookkeeping as a necessary part of an agricultural education becoming more specific and detailed over time.

From the earliest contributions by Tesdorpf and Sehested it had become clear that accounting could only be really useful for farm management if some meaningful guidance existed as to when a result was good or bad, or which results could be expected under prevailing market and institutional conditions, with certain breeds of cows or under given practices of feeding and milk processing. From 1876, TfL started to publish a regular and standardized series of accounts from dairy units of different sizes all over Denmark. In the first attempt regional accounts were gathered and separately published for 1876 and 1877 for the regions of Zealand (Valentiner 1876, 10 farms), Funen (Schroll 1876, 12 farms; Schroll 1878, 17 farms), Lolland-Falster (Bockelmann 1877, 16 farms), Jutland (Winkel 1877, 15 farms; Winkel 1878, 24 farms) and northwest Jutland (Leegaard 1878, 9 farms). From 1879, this work became standardized and summarized for all of Denmark, initiating a regular series of articles called “Mejeribruget i Danmark” with Winkel’s (1880) survey of the accounts of 28 farms for the 1878–79 production year.
Winkel also edited the report for 1880, after which Christian Sonne took over until the 1884 report published in 1885. From then, Bøggild was in charge of the report until well into the twentieth century. Individual farms would keep similar accounts, for example via the blank books and similar forms promoted by Segelcke and others, and could thus compare their own decisions and accounts to those given there, and might be convinced to change their method of farming. For example, from 1878–79 we find printed tables in the archives of the Basnæs estate (located in West Zealand), which serve to record and consolidate annual records on dairying and assess productivity and efficiency in milk, butter, cheese and pork production in a way that is compatible with the published tables in TfL. In a similar vein, the weekly journal of the association of dairy technicians, Mælkeritidende, founded in 1889, continued the tradition of publishing accounts on their pages, although initially in a much less systematic fashion.

That this development was probably unique to Denmark is apparent from the writings of foreign observers as early as 1866, when John Wilson, Professor of Agriculture at the University of Edinburgh, reported on Denmark in connection with the Agricultural Exhibition held in Aarhus that year (Wilson 1867). He praised the accounts of Valentiner’s Gjeddesdal estate as “kept with scrupulous exactitude, even to the smallest details” (ibid., 63). “Mr. Tesdorpf, like Mr. Valentin[sic, -er], believes in the importance and value of strictly-kept ‘Farm Accounts,’ and can turn to his ‘ledger’ and give the debtor and creditor statement in produce as well as in cash returns, of every department of his farming since he came into possession of the property.” (65) “… [His] statement of the dairy returns… not only testifies to the care and exactitude with which the ‘Farm Accounts’ have been kept, but also gives an analysis of the dairy returns of a farm for a longer period, upon a large scale and with a greater minuteness of detail than has ever before been published” (67). He described the “rule of thumb” used in the UK, as opposed to Denmark where “a philosophic treatment, based on sound scientific principles, is the rule and not the exception”. H.M. Jenkins, the head of the Royal College

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28 Landsarkivet for Sjælland, m.m., QA010, Basnæs Gods, Mejeriregnskabner 1878–1899. Since none of the anonymous data surveyed by TfL in this or subsequent years matches with the archival information for Basnæs, we can assume that those accounts were not standardized just for TfL. In Henriksen et al. (2012) we could without problems incorporate the data for Basnæs into a comparative database based on the TfL sample.
of Agriculture in Cirencester, would later make similar statements in a series of reports (Jenkins 1876, 1882).

Thus, over a time span of less than twenty years, almost all important debates regarding the productive specialization in Danish dairying and other farm activities surrounding it were settled by examining the detailed accounts for material flows on landed estates, spurred on by the price signals observed on the farm and overseas, and the competitive conditions of the first globalization. Farmers learned that dairying was more profitable than meat production, that newer methods of cream separation were superior, and, above all, that recording, bookkeeping and accounting were the technologies necessary for understanding and transmitting what was happening on individual farms. Thus, a group of progressive estate owners initiated a program which was to lead to specialization in dairying as well as improvement within this specialization, first by themselves, and then to smaller farmers through the cooperative movement. As Smith explained, competition led to specialization, and this in turn led to improvements in productivity, first in the first stage of production, milk production (Lampe and Sharp 2015b), and then in the second, separating the cream (Henriksen et al. 2011). This did not of course strictly speaking represent development out of agriculture, but the new agriculture which emerged had a decisively industrial nature (being based around steam-powered butter factories), and is often considered to have stimulated industrialization in the cities, for example with the manufacture of automatic cream separators and refrigerators, as well as the ships that were needed to transport the agricultural products overseas (Henriksen 1993). These might of course be seen to correspond well with Smith’s second and third stages in his natural progress of opulence, although a longer discussion of this is outside the scope of the present work.

5. Conclusion

We have presented the case of Denmark in the nineteenth century in order to look for evidence of the mechanisms presented by Adam Smith, whereby the invisible hand leads to specialization and ultimately productivity improvements, and asked how the transition from (basic) agriculture into more sophisticated uses of ‘capital’ is related to
this. In Denmark, a class of large landowners became entrepreneurial farmers, and as markets integrated they looked to take advantage of this, in part by finding out how to best conduct agriculture and thereby also working out what was most profitable for them to specialize in. They did so through developing increasingly sophisticated systems of agricultural accounting, from the records of which we can discern the development of a new way of thinking. This emerged in Danish agriculture through the activities of a group around Tesdorpf, Valentiner, Friis (often later erroneously considered the father of modern accounting in Danish agriculture, see e.g. Segelcke 1891), Buus and Segelcke\textsuperscript{29} who, by the 1880s, had successfully spread their agenda of dairy accounting and scientific agriculture. This took hold during a period of uncertainty generated by changes both at home and abroad. They interpreted their accounts in order to provide prescriptions for others and solutions, which we observe in particular through the pages of the agricultural press, thus helping to systematically advance the two pillars of a “Smithian” program for economic growth: what to specialize in and how to avoid the trap of falling prices by improving productivity through advancement and diffusion of “best practice”. Finally, they institutionalized this through accounting guides, educational establishments, and periodical surveys of farm accounts. The ultimate specialization of the country with the emergence of the cooperatives in the 1880s was to lead to rapid development, and what we might even, in the light of the discussion above, term Smithian growth through specialization and trade.

At the same time, we have attempted to demonstrate that historical empirical evidence can shed light on how classical writings in economics, although surely context-specific to the time of writing, might still constitute economic theory today, and not just stepping stones to “modern” theory. There are similar approaches in related disciplines, in our case the most obvious example being accounting history. Indeed, as mentioned above, one of our main inspirations has been Bryer’s attempt to confront Marx’ writing and understanding of return on capital invested with actual accounting from before, around

\textsuperscript{29} Sehested died in 1882.
and after he wrote, thus providing an way to date transitions from feudalism to capitalism based on clearly identified “accounting signatures”.30

30 In Lampe and Sharp (2017, 91–92), we concluded based on a study of earlier developments in Danish accounting, that “In a broad sense, we can agree with Bryer (2000a, 2000b) that the accounts and tables presented reflect a transition from late-feudalist to capitalist (or commercialised) agriculture, even more so than in the English case”. The evidence presented here can also be seen as demonstrating that Denmark rapidly adopted capitalist accounting following a revolution in its social means of production. We are grateful to an anonymous referee for this important point.
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Figure 1: Relative prices of animal products and grains in England, 1818–1900

Source: Data underlying Henriksen et al. (2012).
Figure 2: Share of animal production in the gross value of Danish agricultural output, i.e., the sum of animal and grain production, 1818–1900

Source: Data underlying Henriksen et al. (2012).