

Structural development of livestock farms in a global perspective

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ABSTRACT: Structural development in agriculture has several international dimensions, and the topic is relevant and important for several reasons. There is a wide range of economic, structural and technological drivers that in a complex context both inhibits and promotes the structural development. The structural development in agriculture and in the livestock sector has obvious international trends, where number, size, concentration, specialization of farms and herds change. While rich countries have fewer and larger farms, the development is just the opposite in a number of developing countries. The rich countries have the lowest concentration and the greatest equality in the structure of ownership, and it illustrates that structural development towards increasing size does not necessarily mean an increasing concentration. In a global perspective a strong correlation between the concentration in the society as a whole and in agriculture is seen. The vertical integration in the form of contract production and cooperative ownership is increasing in several places in the world. Labor emigration from agriculture is also a general feature during economic development, and this will intensify labor productivity and unlock resources for other sectors.

INTRODUCTION

The structural development in agriculture and especially in livestock production has obvious international dimensions, and the topic is interesting and important for several reasons:

First, the structural development becomes increasingly important as an international competitive parameter as trade liberalization removes subsidies, import tariffs and other protective measures. With increasing international competition and fewer ways to protect domestic agriculture, it will be necessary to utilize the advantages within size and economies of scale which the structural development may cause.

Second, in some areas, there are large differences in the structural development between developed and developing countries. The structural pressure is completely opposite in the two areas when it comes to farm size measured as hectares per farm. The general picture is that the farms grow bigger in developed countries and smaller in developing countries.

Third, the structural development will be lagged from country to country. In some pioneering countries the structural development is several years ahead of the developments in other countries. This allows us to use the development of these pioneers to predict the future structural development in other countries. It can also be expected that developing countries at some stage will follow the structural development of developed countries.

Fourth, the structural development measured as the number of livestock per farm shows a relatively uniform international pattern. Farms are smallest in the poorest countries, but the trend towards more and more livestock per average farm is seen everywhere in the world. This means that in particular the livestock sector is a sector where developing countries have opportunities to utilize economies of scale and to gain from structural development.

Fifth, the structural conditions including size, specialization, types of ownership and vertical integration are increasingly important as a result of both technological progress and globalization.

Sixth, it is likely that globalization and liberalization in many ways lead to trends being more uniform seen in a global perspective. With still more consistent and liberal market conditions it can be expected that also farm structures across borders will be more uniform.

Structural development in agriculture:

Definitions and dimensions. The structural development in agriculture can be defined and described in many different ways. Structural development is more than just the size of the individual farm and the number of farms. Also factors such as specialization, concentration, types of ownership, vertical integration, globalization, etc. help to describe the structure.

In the recent years structural development in agriculture has become an even broader meaning. With a greater focus on vertical integration, structural development now covers all the links in the value chain from research and development, supply, agricultural production to processing, refining, distribution, marketing, retail and consumption. Thus, the entire food system is involved.

The changes now take place in new dimensions, where industrialization and business development are in focus.

A number of factors can be used to describe the structural development of farms:

The number of farms is an important parameter in the structural development of agriculture. While the structural development within developed and within developing countries is rather similar, it is very different comparing developed and developing countries. The development in number of farms is also a trend, which is very visible to the rest of society.

Farm size is also a very visible result of structural development. Although the average conceals a wide spread, and although size can be measured in several different ways, farm size is an important yardstick. Seen in relation to national regulations, farm size is one of the structural parameters which is regulated.

Size can be measured as:

- Land (owned or operated)
- Labor
- Livestock units
- Turnover
- Value added
- Capital

Specialization describes the production setup of individual firms. The specialization is increasing if, for example, there is a shift towards less diversified production on the individual farms. Specialization in livestock production occurs also eg. when we have fewer farms with mixed livestock such as farming with both cows and pigs. Also here we are dealing with a very significant development.

An increasing **concentration** will take place if large farms are securing an increasing share of the total production. For instance one can see whether the 20 per cent largest farms accounts for an increasing share of total production. Similarly, one can see whether the small farms become relatively smaller.

In general, the concentration is becoming more widespread. Concentration takes place on individual farms where the big farms have an increasing share of total production.

Concentration also occurs **geographically**, where production becomes more concentrated in areas that have the greatest comparative advantage. Livestock production can develop very differently from area to area. It is thus characteristic that livestock density has been increasing very much in certain geographical areas.

Form of ownership is central as it describes the ownership of the farms. A distinction is made between different types of ownership; private ownership, tenancy, limited liability companies, cooperatives, fund ownership, etc.

Vertical integration, including specific contract production highlights the food industry's connection and dependence on suppliers of raw produce (farmers) and buyers (retail). The entire value chain from research and development right through to the final end user is often involved. With increasing degree of vertical integration, farms more and more become a part of the industrial process, arising from consumers' demand and traced back through the value chain to the farmers.

Input factors in agriculture are also rapidly changing and are also an essential part of structural development. Input factors in this context cover, labor, capital, education, etc. The change is visible by the share of respectively full and part time farms, non-farm earnings, etc.

Globalization / internationalization are also sometimes included in the description of structural development. The farms' relative sales on the export markets often increase over time, and thus an important structural characteristic of the farms changes. Farmers investments in foreign agriculture, cooperation with farmers abroad can also be included in the description of structural development in agriculture.

Framework for structural development on a global level

Viewed in a comprehensive and global perspective the size of farms depends on the size of production and the production base (number of animals, hectares, etc.) and the number of farms and farmers. If production increases quickly or if the emigration of farmers from agriculture to other sectors is strong, it may create a development towards increasingly fewer but larger farms.

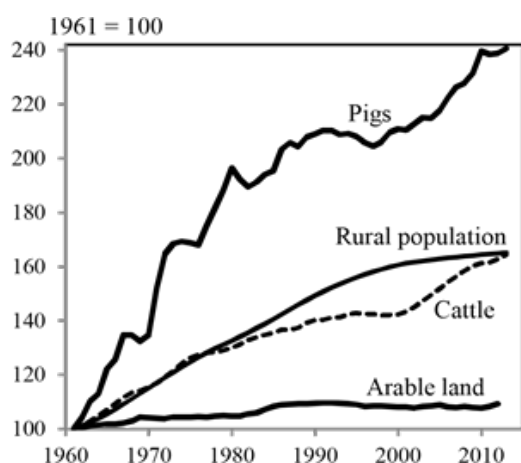
When it comes to the number of hectares per farm, it is characteristic that the world's total agricultural arable land is relatively constant. Over the past 50 years, it has only grown by around 10 per cent. Thus, there is no growth or structural driver hidden in this trend of the total agricultural area. When growth in the agricultural population at the same time has been much greater, it will cause a smaller area per farmer and thus a smaller average size of the farms *ceteris paribus*.

The development is illustrated in **figure 1**.

When it comes to livestock farms, there has been a much stronger growth. The stock of pigs and cattle in the world has increased by 140 and 60 per cent in the period, and thus there is up front a greater contribution to the structural development of livestock farms. In the same period, the agricultural population in the World increased by 60 per cent. This means that the number of live stock has increased more than the agricultural population and this will ceteris paribus affect the structural development in the direction of increasing livestock farms.

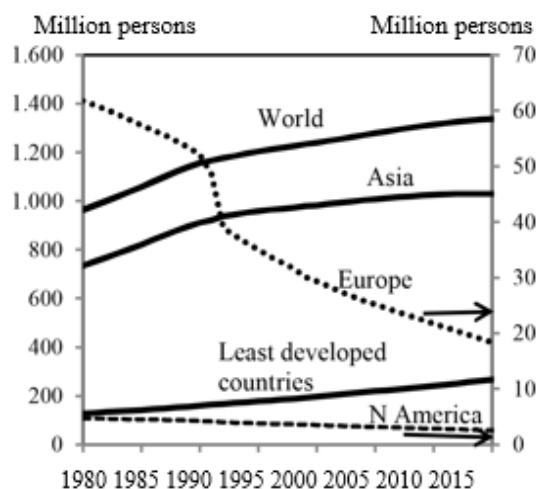
The development of the economically active population in agriculture is very different from region to region. In developed countries there has for many decades been a strong emigration from agriculture to non agricultural industries, while in developing countries there is still an increasing number of farmers, see **figure 2**.

Figure 1. Pigs and cattle (stock), rural population and arable land, world total. 1961 = 100



Source: Author's own presentation based on FAO (2015)

Figure 2. Total economically active population in agriculture, 1980-2015



Source: Author's own presentation based on FAO (2015)

These two completely different developments are crucial for agricultural structural development in a global perspective. When the number of farmers increases, there will be a smaller agricultural area per farmer, and it will result in still smaller farms and that structural development goes backwards.

Drivers

In addition to the overall and global framework behind the structural development one can identify a number of economic, structural and technological conditions, which in a complex context both inhibits and promotes the structural development. Theoretically it is easy to set up a number of causes and drivers of structural change; however, it is much more difficult to demonstrate any statistical causality.

The driving forces behind the structural development are important:

Firstly, it will be interesting to clarify the options or instruments you may have to strengthen or restrict the structural development through the agricultural policy.

Secondly, it will also be interesting to see to what extent market conditions etc. affect structural development. In that way, you will better be able to explain and predict the agricultural structural development.

In practice it is difficult to identify and document the specific causes of structural development. A Danish research report (Wiborg, T. and Rasmussen, S. 1996) concludes that „it has not been possible to identify factors that particularly affect the structural development in agriculture“.

A study by Huffmann, W. E and Evenson, R.E. (2001) shows, however, that research and development, education, market conditions directly affect structural development, although the entire structure development cannot be explained.

All in all, it should be noted that it is very difficult to prove any causal relations behind the agricultural structural development. This also makes it difficult to detect significant effects of new initiatives, external shocks etc. on the structural development of agriculture.

Firstly, there are many permanent and many different impacts on agriculture, where it may be impossible to separate the individual effects and their consequences.

Secondly, often there is a long or short period between exposure and a visible consequence. Lags are important in the structural development.

Thirdly, agriculture and farms are in general so heterogeneous that responses to the impacts may be very different from farmer to farmer.

Fourthly, farmers may to some extent expand and buy farms from non-economic motives. It can be very difficult to incorporate these motives in a empirical explanation of agricultural structural development.

Finally, **fifthly**, a stimulus (e.g. an income increase) may have very different and perhaps opposing effects depending on the circumstances.

As the structural development covers several different conditions, there are also several reasons for this development. Contract production occurs of special reasons, while e.g. changes in forms of ownership or farm structures have other causes.

In the following different causes of structural development in agriculture are identified and analyzed theoretically and statistically.

Based on the theoretical and empirical assessments of the structural impacts on agriculture, a general overview of the causes of structural development in agriculture is given in **table 1**.

Table 1. Structural development in agriculture: Drivers and impacts

Driver	Impact
Technology	Increasing emigration, Fewer farms, Larger farms, Increasing concentration, Increasing specialization, More part time farms, Vertical integration.
Economies of scale	Fewer farms, Larger farms.
Profit	Decreasing emigration, Increasing immigration, Existing farms grow bigger, Increasing specialization
Wage trends in non-agricultural sectors	Increasing emigration, Decreasing immigration.
Infrastructure	Increasing specialization, Increasing vertical integration, More part time farms.
Agricultural legislation	Decreasing vertical integration, Increasing vertical integration, Decreasing concentration, Decreasing specialization, Increasing specialization, Limits growth of farm size, Decreasing emigration.

Source: Own presentation

For example, the table shows that economies of scale stimulates the structural development towards fewer but larger farms. At the same time, increasing wages in non-agricultural sectors will result in increasing emigration from agriculture, and this will intensify the structural development. The list is hardly complete, and there will always be exceptions, special cases etc. where other conditions apply.

Number of farms

Structural development measured by the change in the number of farms is largely uniform within the economically developed countries. In developed countries, there is a relatively clear trend towards fewer and fewer farms from year to year, and the trend is seen in many countries. The number of farms in countries like Denmark, Sweden and the United States has thus evolved relatively the same way over the past little century, see **figure 3**.

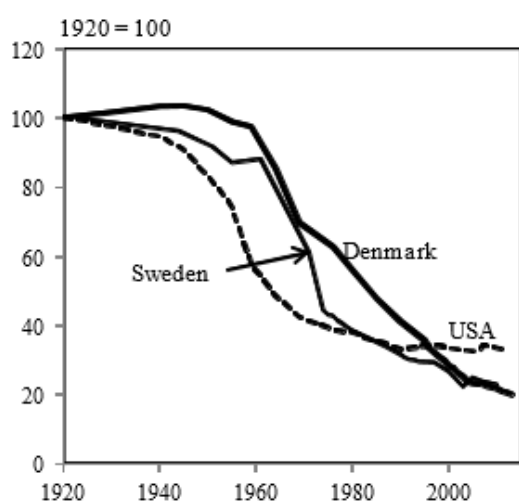
As the figure shows, the development in the three countries has been rather uniform. It is also shown that Denmark had an almost constant number of farms up until the early 1960s. This was largely due to an agricultural policy regulation in the form of subdivision of land and public establishment of smallholdings, which slowed the structural development and maintained a relatively large number of farms.

The development was fastest in the United States, which can be explained by the agrotechnical development and mechanization, which was more advanced in the United States, as well as demand for labor in other sectors which pulled labor out of agriculture.

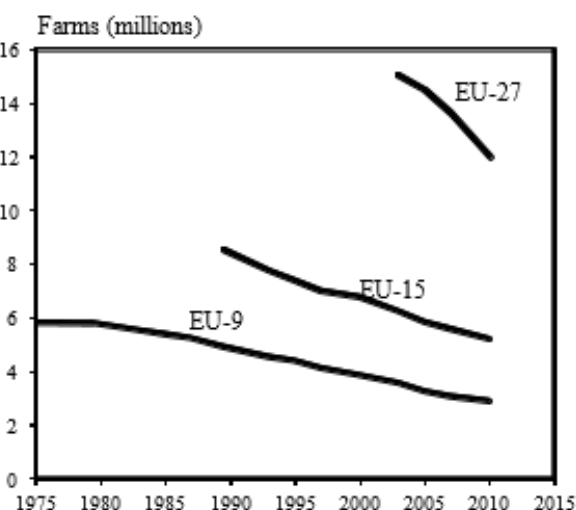
However, over most of the 20th century, the development of agricultural holdings in the three countries remained the same and ended with the same result: The number of farms is reduced to 20-30 per cent in Denmark, the US and Sweden. The industrialization and mechanization of agriculture in the 1950s and 1960s seems to have affected the structural development significantly.

In all EU countries the number of farms has been decreasing year by year. In the period 1990-2010 about 40% of all farms have disappeared, when looking at the EU as a whole, see **figure 4**.

Figure 3. Development in the number of farms in selected countries. **Figure 4.** Number of farms in the EU, 1975 to 2010.



Source: Author's own presentation based on Statistics Denmark, Statistiska Centralbyrån (several issues) and USDA (several issues)



Source: European Commission (several issues)

Whether you look at the EU-9, EU-15 or EU-27, there is a clear trend towards fewer and fewer farms.

It is noteworthy that the development in recent years in particular has been rapid in the least developed countries - including the new EU countries - while the most developed countries have had a far weaker structural development. This is largely due to the fact that in the 1960s to the 1990s the rich countries already had a strong trend towards fewer farms, and therefore the structural pressure was weaker afterwards.

However, for all countries as a whole there has been significant decline in the number of farms in the period.

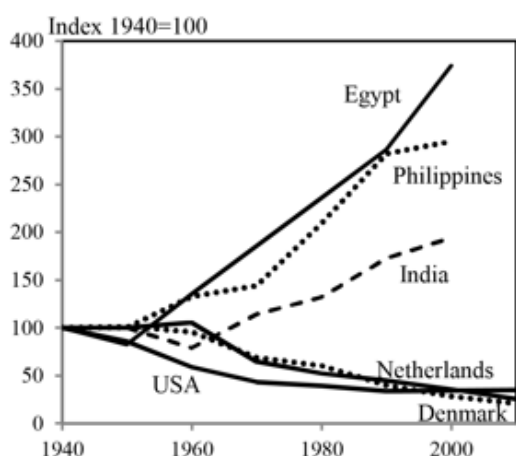
In a global perspective, the picture is not so clear. On the one hand we have countries which in a relatively uniform way have a development towards fewer and fewer farms a trend that has occurred since the mid1900s.

On the other hand we have the developing countries, where we see the opposite trend namely the emergence of more and more new farms so that the total number of farms is increasing. Demographics, the relatively little emigration away from agriculture and a very small growth in the agricultural area are the main explanations why the structural development is so different in most developing countries.

As an example, major countries like India, Egypt and the Philippines have had a significant increase in the number of farms, see figure 5.

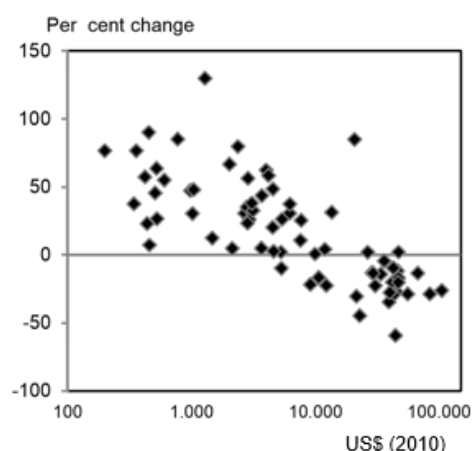
The pattern towards more and more farms can be found in a number of developing countries, including for example Congo, Ethiopia, Kenya and Malawi. Thus, there is a very clear international pattern in which the number of farms is increasing in the poor countries, while falling in the richer countries, see figure 6.

Figure 5. Number of farms 1940 = 100.



Note: India 1950 = 100. Source: Own calculations based on FAO (2013).

Figure 6. Per cent change in number of holdings 1990-2000 and GDP per capit



Note: Change 1990 2000 or last recent decade with available data. Source: Author's own presentation based on FAO (2013) and World Bank (2015)

As the figure shows, that the number of holdings in developing countries is increasing, while it is decreasing in the more developed countries. The pattern and correlation can be explained by a number of factors, which are listed in table 1. The emigration of farmers to other sectors in developed countries is a major factor. There are both “pull and push factors”: Labor force is attracted by other sectors with labor shortages, and labor force is pushed out of agriculture because of low payment and use of technology. Utilization of economies of scale and mechanization are also important factors that could explain both emigration and structural development towards fewer and larger farms in the most developed countries.

Size of farms

The average size of farms - measured in several different ways - varies considerably from country to country - even within the EU. The farms in the Netherlands and Denmark, which have relatively high average sizes, is many times greater than in for example Romania - depending on how you measure the size, see table 2.

Table 2. Average farm size in individual countries in EU, 2010

	Gross value				
	Hectares	Dairy cows	Pigs	Output 1.000 €	Added 1.000 €
Belgium	32	46	1.092	203	57
Bulgaria	12	4	8	12	5
Czech rep.	152	123	477	212	59
Denmark	63	134	2.598	290	88
Germany	56	46	459	183	57
Estonia	48	27	251	47	19
Ireland	36	58	1.253	50	13
Greece	5	23	49	15	8
Spain	24	31	354	44	22
France	54	45	569	153	63
Italy	8	35	356	30	16
Cyprus	3	103	524	19	9
Latvia	22	6	21	16	4
Lithuania	14	4	14	15	6
Luxembourg	60	57	598	199	58
Hungary	8	22	18	12	4
Malta	1	48	543	11	5
Netherlands	26	75	1.743	370	119
Austria	19	11	86	49	20
Poland	10	6	39	15	6
Portugal	12	27	38	21	7
Rumania	3	2	3	4	2
Slovenia	7	10	14	16	5
Slovakia	78	25	55	100	24
Finland	36	24	657	80	26
Sweden	43	62	894	92	27
U.K.	84	78	445	160	57

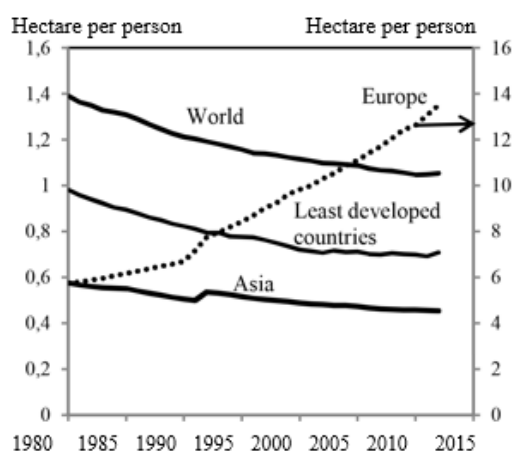
Source: Author's own presentation based on European Commission (2014)

There is a clear pattern in the direction of, that the largest farms are found in Northern and Western Europe, while the smallest are found in Eastern and Southern Europe. The general picture shows thus that the richest countries have come furthest in the structural development, while small average farms typically are found in the poorest countries. It is remarkable that there are so big structural differences in agriculture, even within the same region and in the same economic and political union. Agriculture operates in the same market and within the same overall market policy framework, yet it is possible to have very large structural differences. The explanation is that between countries there are also major differences in the economic level of mechanization, industrialization, rural emigration, etc., and these differences imply different drivers of structural change. With the current development however, the gaps will gradually be reduced.

The correlation between the size of farms and the countries' level of economic development can also be found in a completely global perspective: In the poorest countries, farms are small, and they are generally getting smaller over time, while the opposite is seen in the richer countries. In the very global level there is a clear trend towards more and more farmers and others who are economically active in agriculture. As the agricultural land is not increasing much, the agricultural land per farmer is decreasing. This trend is particularly pronounced in the least developed countries, while the developments in the richer countries are going the other way: Here, the agricultural land per farmer is increasing, see **figure 7**.

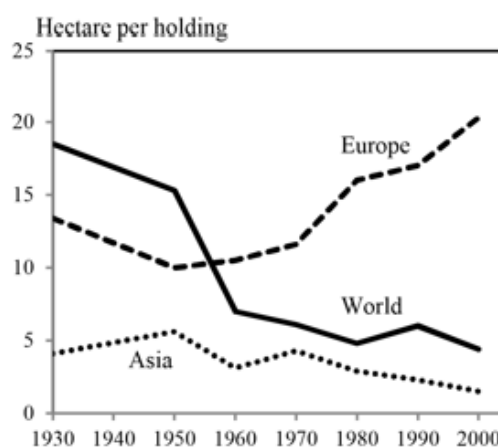
Arable land per economically active person in agriculture is an overall way of illustrating farm structure. A more detailed analysis, which examines area per farm, however, provides an almost identical development: The farms become larger in developed countries and smaller in developing countries, see **figure 8**.

Figure 7. Farm structure: Arable land per economically active person in agriculture



Source: Author's own presentation based on Statistics Denmark, Statistiska Centralbyrån (several issues) and USDA (several issues)

Figure 8. Farm structure: Average number of hectare per holding

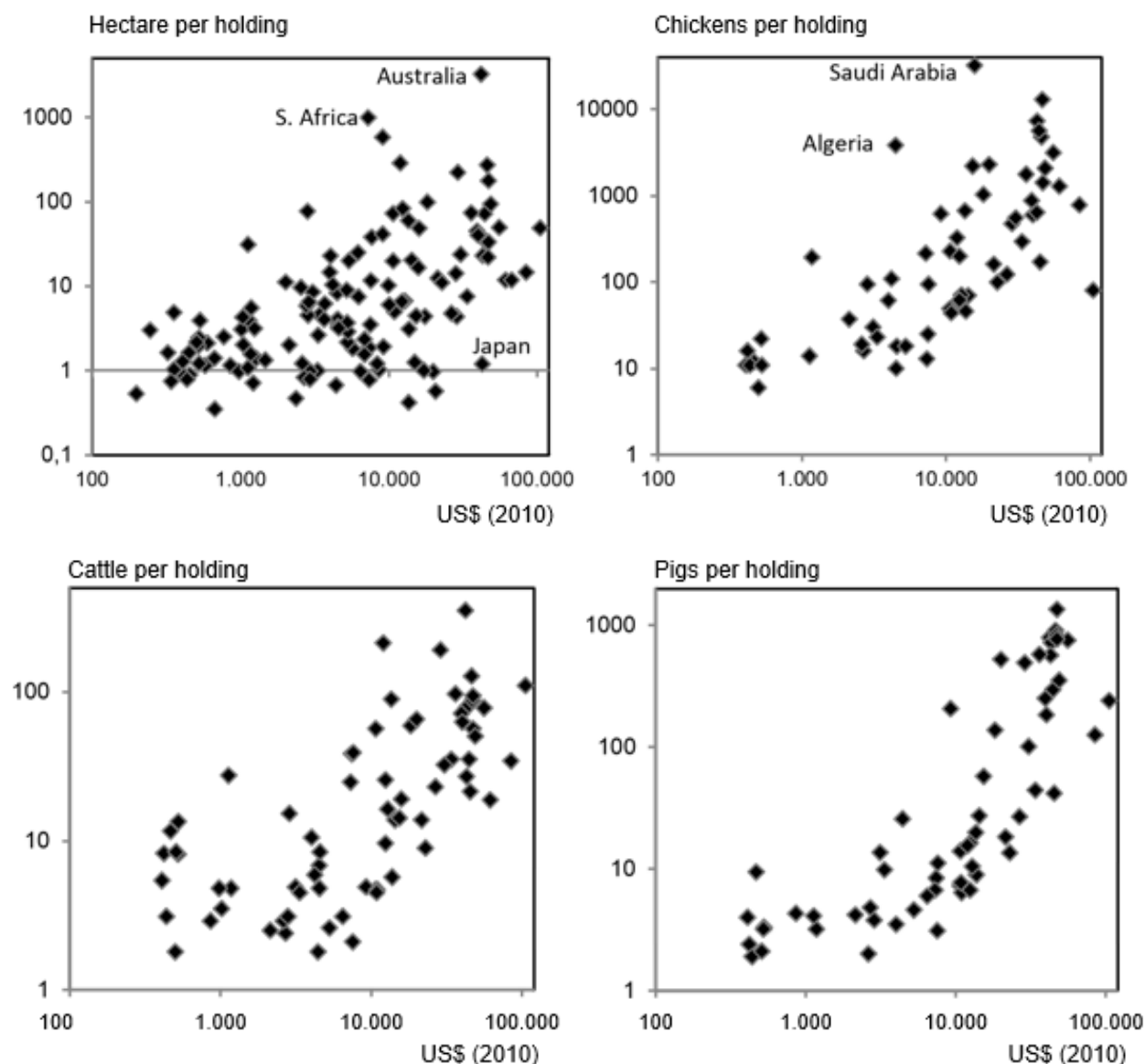


Source: Author's own presentation based on FAO (2013)

Figure 8 shows the average changes in farm size worldwide, in Europe and in Asia. It is clear that the farm size in Asia and Europe is developing in different directions. In the same period, the average number of hectare per holding in North America increased from 49 to 74, which also confirms the general trend towards larger and larger farms in the most developed countries.

By comparing the countries' level of economic development and their farm size calculated as both land size and number of livestock per farm - one can see that there is a clear correlation: Farm size and herd size increase with increasing economic development, cf. figure 9.

Figure 9. Size of farms and herds and GDP per capita



Note. Data for 2010 or last year with available data. Some countries with deviant position are indicated. Logarithmic scale on both the X and Y axis.

Source: Author's own presentation based on FAO (2013) and World Bank (2015)

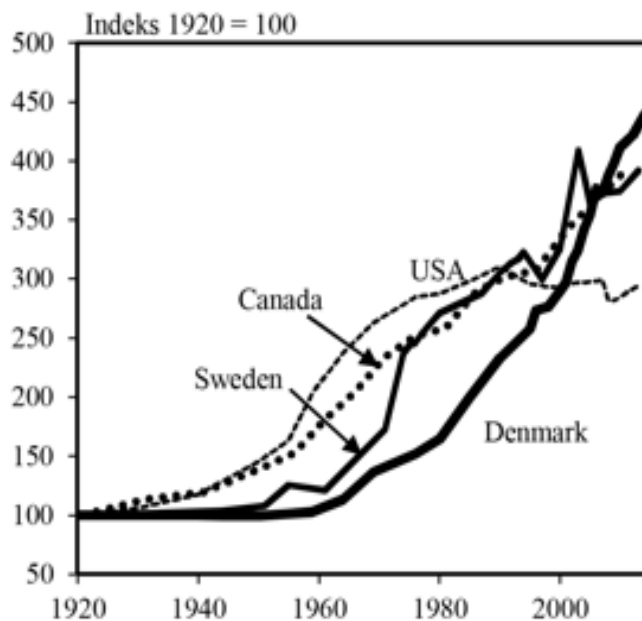
Figure 9 shows the size of farms and herds as a function of GDP per capita for up to 140 countries. As the figures show, in particular for livestock there is a clear correlation between countries' economic welfare (GDP per capita), and the herd size. A few countries deviate from the pattern, but here it is often due to political conditions, which contributes to regulate the structural development.

The figures also show that the correlation is highest for livestock, and that there seems to be no clear correlation for the poorest countries, i.e. countries with GDP <5.000 USD per capita. The correlation seems to be lowest for pig holdings in the poorest countries.

Although use of cross section data, a dynamic interpretation is possible, and we can assume that the development in each country over time will follow the pattern shown in figure 9, as the countries get richer and richer. This dynamic interpretation can be supported by the development, which the size of farms and livestock herds have shown for a long period in developed countries.

In the Western world in general, there has been a very consistent trend towards larger and larger farms - a development that particularly has accelerated in recent decades, see **figure 10-12**.

Figure 10. Farm sizes (hectare per farm) in Denmark, USA, Sweden and Canada.
Index 1920 = 100



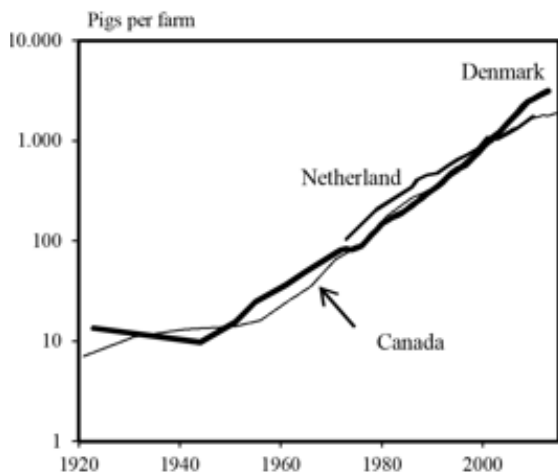
Sources: Author's own presentation based on Statistics Denmark (several issues), Statistics Canada (2009 + 2015), USDA (several issues) and Statistiska Centralbyrån (several issues)

Figure 10 shows that the four countries have had a very uniform development when considering the whole period. The farms have become about 3-4 times as large, although movements in the 20th century have been somewhat different.

When it comes to the developments of the livestock farm size, an almost uniform international

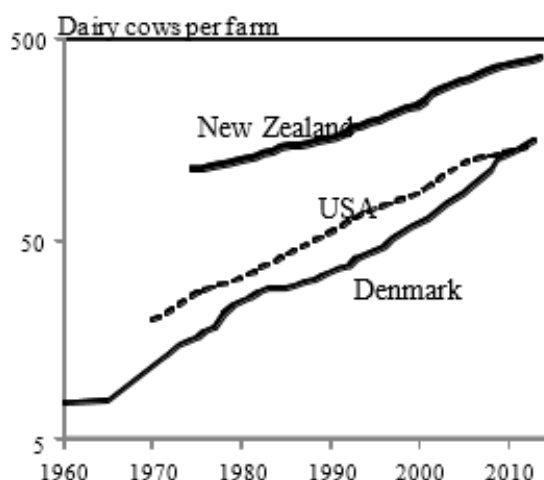
patterns can be observed, see **figure 11 and 12**.

Figure 11. Number of pigs per herd in Canada, the Netherlands and Denmark.



Note: Logarithmic scale on Y axis.
 Sources: Author's own presentation based on Statistics Denmark (several issues), Statistics Canada (2009 + 2015), European Commission (several issues) and Statistiska Centralbyrån (several issues)

Figure 12. Number of dairy cows per herd in USA, New Zealand and Denmark.



Note: Logarithmic scale on Y axis.
 Sources: Author's own presentation based on Statistics Denmark (several issues), DairyNZ (2014) and USDA (2007 + 2014).

The figures underlines unanimously that countries apparently follow a relatively uniform pattern, when it comes to structural development of livestock farms in a global perspective.

Especially during the last few decades structural changes have taken place, but even over a longer period structural changes in for example pig production has been almost exponential.

The figure has a logarithmic scale on Y axis, and we see that there is an almost straight curve for all three countries over the last decades.

Specialization

The specialization in agriculture - and in many other industries - has been increasing in recent years. Specialization in this context is specialization on the individual farms, whereby production is less mixed, and whereby farmers focus on one single branch of production.

The increased specialization is due to the technological developments that increasingly create economies of scale. Furthermore, the increasing demand for specific knowledge will mean that farmers will focus on fewer and perhaps only a single branch of production.

One example is poultry production, which previously took place on almost all farms. With increasing specialization and division of labor poultry production is now occurring on fewer and fewer farms. The remaining poultry production now takes place on larger and often very specialized farms. The development is not an indication that the poultry production loses importance, but rather an indication of industrialization and specialization.

The development is seen in many places. As an example, **figure 13 shows** the share of farms with poultry in the United States, Sweden and Denmark over a longer period.

The increasing share after 2000 is mainly due to several very small farms with a relatively small number of animals. The general pattern shown in figure 13 can be found in many places in the Western world. Also here there is the trend towards more specialization and less diversified agriculture.

Concentration

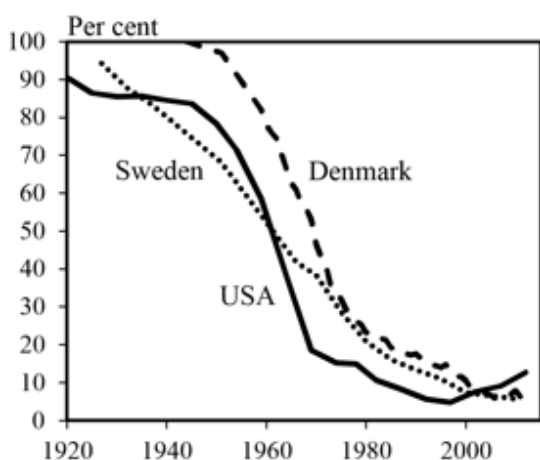
The concentration can be illustrated by calculating the share of the total production, which the 5 percent or 20 percent largest farms produce. If these largest farms have an increasing share, it is evidence of increasing concentration. The concentration - or rather inequality - can also be measured by the Gini coefficient, see e.g. Hansen (2013).

Increasing concentration in agriculture is a phenomenon in many countries. In the United States 3,8 per cent of farms accounts for 66 per cent of all farms sales, and 37 per cent of the land is owned by 1 per cent of the farmers. In 2012 5 per cent of farms produced 45 million pigs, equivalent to 68 per cent of the total pig production in the US (USDA, several issues).

In these examples, there is a very skewed distribution in which a small part of the farmers have a relatively large share of the total production.

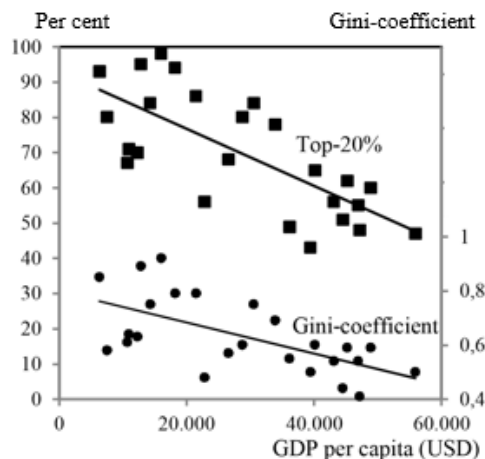
Figure 14 shows an example of concentration and inequality in agriculture in different EU countries.

Figure 13. Share of farms with poultry



Note: USA: With chickens, Denmark: With hens,
 Sweden: With hens, without chickens
 Sources: Author's own presentation based on Statistics
 Denmark (several issues), USDA (several issues + 1999)
 and Statistiska Centralbyrån (several issues)

Figure 14. Concentration and inequality in EU agriculture in terms of land size, 2005



Note. The concentration is measured by the farms' land sizes (hectare)
 Source: Author's own calculations based on European
 Commission (several issues)

First, the figure shows the concentration and the share of the agricultural land by the 20 per cent

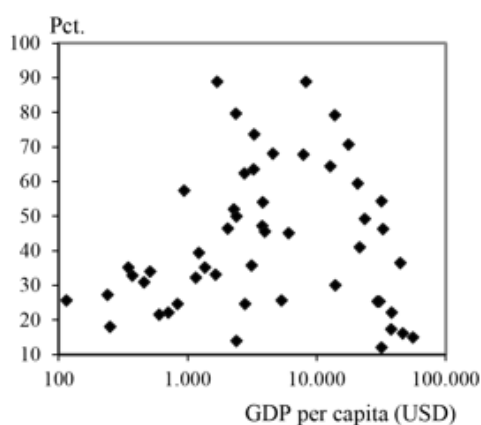
largest farms. As can be seen, these farms have 45-95 per cent of the agricultural land. Second, the figure also shows the equality in farm size distribution - measured by the Gini coefficient. A small value indicates that agricultural land is distributed fairly equally among farms, while a large value means a great inequality.

The figure shows that there are significant differences in both concentration and inequality among countries in the EU. There is, however, also a relatively significant pattern: The rich countries have the lowest concentration and the greatest equality, whereas the opposite is the case of poorer countries, i.e. in Eastern and Southern Europe.

It also means that structural development towards increasing size does not necessarily cause an increasing concentration. On the contrary, countries with average small farms have the most concentrated structure.

The concentration varies among countries and among continents. You cannot conclude that the concentration depends on the level of countries' economic welfare. The relationship between concentration and the GDP per capita indicates that concentration is lowest in the very poor and the very rich countries, while the concentration is highest in the middle group, see **figure 15**.

Figure 15. Concentration in agriculture (share of 5 per cent biggest farms) and economic welfare per capita in the country



Source: Author's own calculations based on FAO (2013)

Countries with the lowest concentration are Finland, Luxembourg, Switzerland, Norway and Denmark. Nordic countries are characterized by a very equal and unconcentrated agricultural structure.

In a global perspective, Europe - along with Asia and Africa - is characterized by a low concentration, while especially South America has a highly concentrated agricultural structure.

Concentration in agriculture in different continents is shown in table 3.

Tabel 3. Concentration in agriculture

	Gini	C-50	C-20	C-5	Obs.
Africa	0,51	83	55	28	10
Asia	0,53	84	58	29	10
Europe	0,58	87	61	34	10
North and Central America	0,75	93	79	57	10
Oceania	0,75	93	79	57	10
South America	0,80	99	83	62	10

Note: Unweighted average. Obs. = number of observations

Source: Author's own calculations based on FAO (2013)

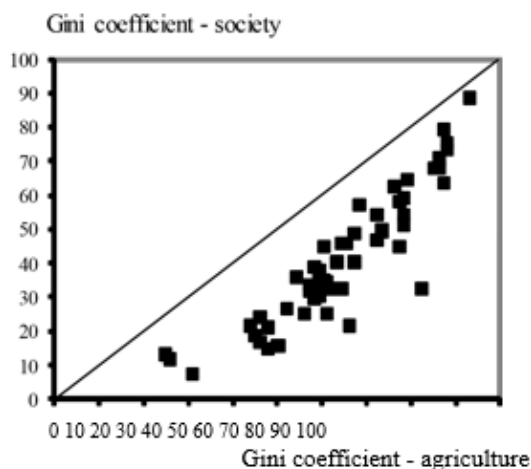
Peru, Paraguay and Venezuela are among the key countries with very high concentration in agriculture in South America.

It is obvious that in countries with a very significant agricultural sector, distribution of assets throughout society will depend on the concentration in agriculture. If a very small part of the population owns a large part of the agricultural land, they will also own a significant share of the country's total assets.

Therefore, for the poorest countries you can expect to find a certain correlation between the concentration and equality on the one hand in agriculture and on the other hand in the total economy.

As **figure 16 shows**, there is for every country a remarkable strong correlation between the concentration in total society and in agriculture.

Figure 16. Concentration in agriculture and in total society: Distribution of agricultural land in agriculture and of the income of the total society



Note: Gini coefficient for agriculture: Distribution of agricultural land among farmers. The Gini coefficient for society: Income distribution among all the inhabitants.

Source: Author's own calculations based on FAO (2013) and World Bank (2015).

There must be taken into account that the Gini coefficients for agriculture are calculated based on distribution of agricultural land among farms, while the Gini coefficients for the whole society is calculated based on income - or in some cases on consumption - among all the inhabitants. Despite these methodological differences, there is a remarkable strong correlation.

Even for developed countries, where agricultural incomes and assets only have a very small share of society's total earnings, there is a close correlation.

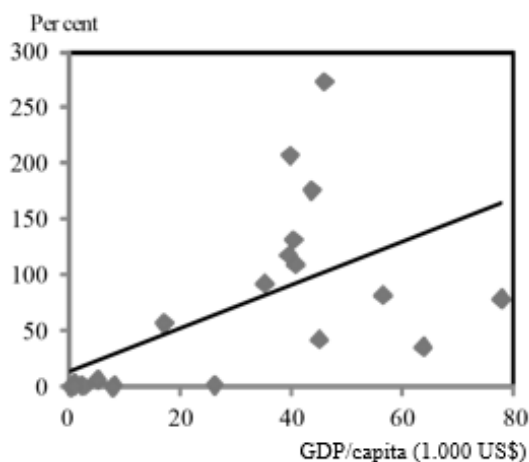
Vertical integration: Cooperatives and contract production

Cooperatives play an important role in livestock business in many parts of the world. Cooperatives differ from other companies as the owners and users in cooperatives are the same. In the agricultural and food sector, cooperatives are especially prominent amongst dairies and slaughterhouses, i.e. livestock based industries.

The degree of cooperative organization in agriculture and the food industry varies significantly from sector to sector and from country to country, which can partly be explained by the different market conditions, which to a greater or lesser degree stimulate cooperative organization. In the case of cooperatives in agriculture and the food sector, a pattern is apparent in that cooperatives are most widespread in North America, Northern and Central Europe and in Japan and Korea.

Generally, cooperatives – of the formal kind – are most important in the most economically developed countries. Here, cooperatives have a relatively large market share and most farmers are members of one or more cooperatives. Figure 17 illustrates the link between farmers' membership of cooperatives and the countries' level of economic development.

Figure 17. Number of memberships of agricultural cooperatives as a percentage of the agricultural population



Note: Farmers can be members of several cooperatives at the same time which is why the percentage can be over 100.

Source: Author's presentation on the basis of Zeull and Cropp (2004).

The figure shows a relatively clear trend: Cooperatives are less common in the poorest countries, while their prevalence increases concurrently with economic growth.

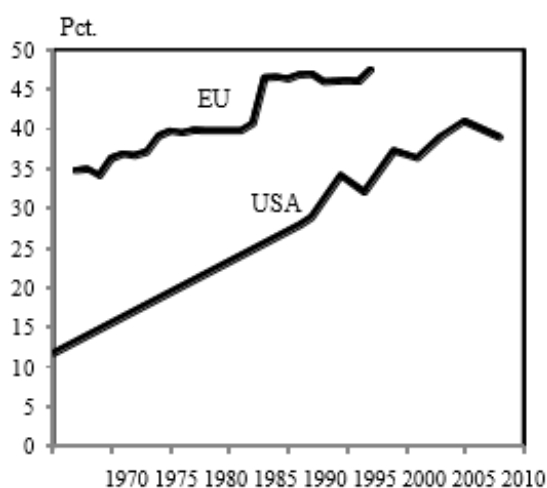
An important explanation is that the establishment of cooperatives requires a certain level of infrastructure, education and organization, which is not always present in the least developed countries.

It is also noteworthy that the cooperative organization is particularly prominent in the processing activities which are close to agricultural production in the value chain, or where agricultural goods account for a large proportion of total costs.

Contract production, as a common example of vertical integration, regulates the relations between, on the one hand, farmers, on the other, private, cooperatively-owned or public companies, so that it replaces the usual spot market. A contract usually includes price, quantity, quality, credit, etc.

The development during recent decades has shown a tendency towards more and more contract production, see **figure 18**.

Figure 18. Agricultural contracts (% of total agricultural production) in USA and EU



Source: MacDonald, J.M., and Korb, P. (2011) and author's own calculations based on European Commission (several issues)

As seen in figure 18 the extent of contract production in agriculture in both EU and US agricultural has increased significantly in the recent decades. The level varies considerably from product to product and from country to country. In the EU, contract production is most widespread when it comes to sugar, peas and poultry production.

For example, in Finland, 80 and 90 per cent of hogs and dairy farms respectively use contracts and this share has been rising (Vavra, P., 2009)

Also in countries outside the EU, the extent of contract production varies widely from country to country and especially from product to product. According to Martinez, S. W. (2007) 70 per cent all pigs in USA were sold through contracts in 2006.

In the US, nearly 90 percent of chicken production was covered by contract production already in the mid-1950s (Martinez, SW, 1999 and USDA, 1999), and the proportion had risen to 97 per cent in 2011, cf. MacDonald, M. (2014). As for turkey production the extent of contract production has increased from 4 per cent in 1955 to 30 per cent today.

The development of contract production in agriculture in a completely global perspective is more difficult to demonstrate, partly because contract production can take many forms, partly because the extent of contract production in many cases cannot be measured statistically. Studies from the US and the EU, however, show a significant increase. In a literature study from Prowse, M. (2012) it was concluded that the expansion of contract farming has taken place in all regions of the world. It was also concluded that contract farming in developing countries has become widespread, and this is due to both supply and demand changes.

On the one hand, contract production is positive because it can reduce transaction costs, improve the efficiency of supply chains, and improve farmers' access to markets and customers. In particular, it can be beneficial in developing countries where infrastructure and access to markets may be limited.

On the other hand, the use of contracts in a concentrated market with significant market power in favor of the processing industry can be problematic. In these cases, contracts will mostly benefit one part, which will not encourage development of the overall value chain.

Kunkel; Peterson and Mitchell (2009) thus show a number of benefits and disadvantages of contract production in agriculture.

Specialization between agriculture and the food industry

The specialization between on one hand agriculture and on the other hand the downstream activities in the value chain is changing in line with economic development in a society: The specialization in the agroindustrial sector will increase.

In a developing country, a significant portion of the supply and processing activity occurs in primary agriculture. In line with economic development, a larger division of labor occurs, so that supply and processing industries take over a significant portion of both the household and agriculture's food processing.

As can be **seen in figure 19**, there is a clear tendency for the food industry to take over a greater and greater percentage of the value added in the agro-industrial complex.

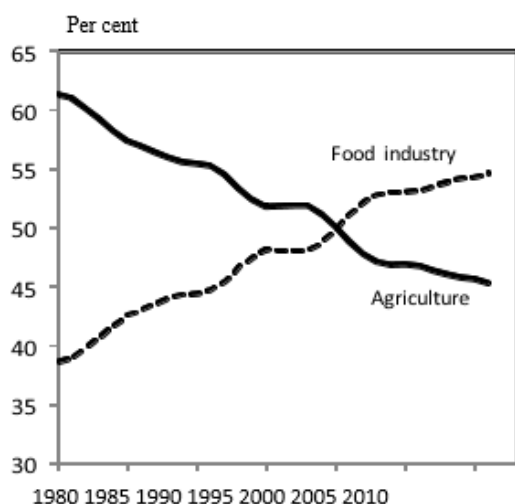
This development will also contribute to reduce the direct significance of the agricultural sector as a result of economic development. However, it must be noted, that in developed countries the role of agriculture increasingly occurs as a secondary effect or spin-off in related sectors.

When primary production and processing takes place in two different sectors, it is important to have a strong and coherent value chain, and an effective market for their products. Thus, there is a considerable need for structural development in the form of vertical integration.

Although the food industry will capture an increasing share of the employment and value added from primary agriculture during economic development, also the food industry will normally have a relatively decreasing importance during economic development. This is due to the fact, that increased processing in the food cannot compensate the negative effect of the low food demand growth etc.

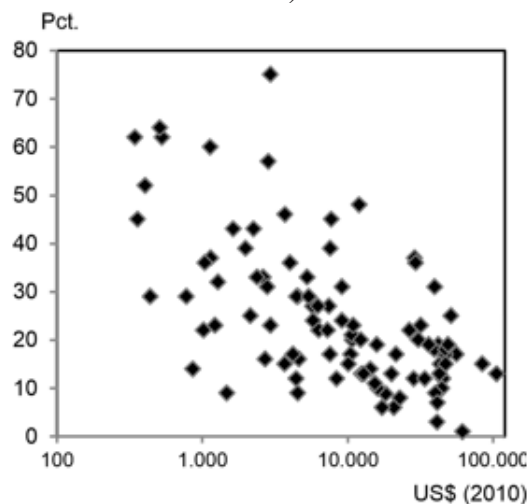
The connection between economic development and the importance of the food industry is **shown in figure 20**. The figure shows that the food industry share of total value added in industry in the poorest developing countries typically accounts for 20-60 per cent, while in the richer part of the world it is typically 5-25 per cent.

Figure 19. Distribution of value added in agriculture and food industry in OECD countries.



Note: Weighted average of 22 OECD countries. Source: Author's own calculations based on OECD (2015) and World Bank (2015).

Figure 20. The food industry share of total value added in industry as a function of GDP per capita (2010 or latest year with available data)



Source: Own calculations based on World Bank (2015)

The figure shows the correlation between the level of economic development and the relative importance of the food industry. As shown, there is a clear negative correlation, where the relative importance of the food industry decreases during economic development.

Input factors

Input factors in agriculture are rapidly changing, and they are also an essential part of the structural development. It is characteristic that the agricultural labor force has dropped much over many decades, and there is a uniform international pattern where the importance decreases with increasing economic and industrial development.

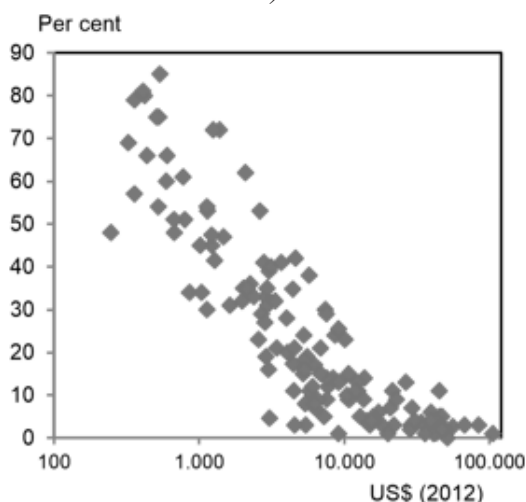
As seen in figure 21, there is a very clear correlation between economic development and the importance of agriculture in relation to employment.

As the figure shows, the importance of agriculture for employment is declining relatively in line with increasing economic development.

The emigration of labor from the agricultural sector results in provision of labor to other industries. The role of agriculture is thus to make resources available that can create value in other sectors.

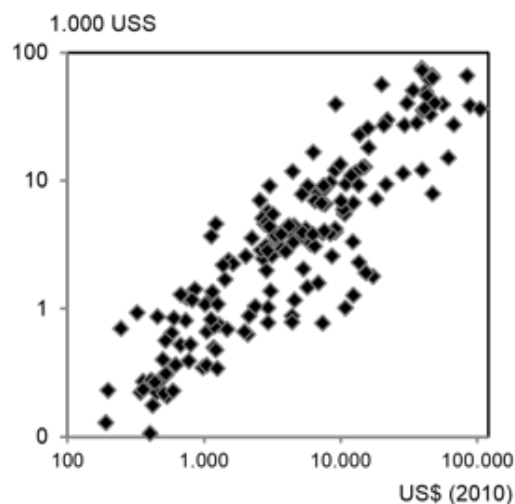
Furthermore, the emigration of labor also means, that fewer and fewer people in agriculture can produce an ever increasing amount of agricultural products. Growth of labor productivity, the amount produced in relation to the work effort, is relatively high in agriculture, and it is particularly high in the rich countries with a well-developed agriculture, see **figure 22**.

Figure 21. Agricultural employment's share of total employment as a function of GDP per capita (2010 or latest year with available data)



Source: Own calculations based on World Bank (2015)

Figure 22. Agricultural productivity as a function of GDP per capita



Note: Value added has been calculated for 2013 or the latest year with available data. GDP per capita is for 2010. Source: Own calculations based on World Bank (2015)

The figure shows for each country the relationship between the level of economic development (GDP per capita shown in logarithmic scale) and the agricultural added value (gross factor income shown in logarithmic scale) per labor unit.

As the figure shows, added value in agriculture per labor unit increases sharply with rising economic welfare. This estimate of labor productivity is also an indication of increasing farm sizes in line with economic development.

The very unique correlation is remarkable, since many factors other than just economic development helps to explain labor productivity, added value and structural development in agriculture, see e.g. Huffmann, W. E. and Evenson, R. E. (2001).

Conclusion and concluding remarks

Structural development in agriculture and in the livestock sector is driven both by some overall global conditions (agricultural land, livestock number and rural population) and some more specific factors such as economies of scale and mechanization. Focusing on the land per holding, the structural development is completely opposite in developed and developing countries, as the farms have an increasingly smaller area in developing countries. Looking at the structural development in terms of the average number of livestock per holding, the development is generally more uniform in developed and developing countries.

Industrialization, emigration of labor from rural to urban areas, specialization between agriculture and the food industry, vertical integration in the value chain and high productivity seem to be important drivers of structural change in a global perspective.

In the long run it is expected that the structural development in agriculture in the developing countries will largely follow the same pattern as in developed countries. In parallel with their increasing wealth, industrialization, increasing agricultural productivity and economic development and in parallel declining population growth - emigration from agriculture is enhanced, and it will intensify structural development in agriculture.

Transfer of knowledge and capital from the Western world can significantly contribute to facilitate this development. To the extent that this development can unlock labor for better salaries in other industries and at the same time produce sufficient and cheaper food, it is a positive socio-economic development.

The risk is that the unlocked labor is inapplicable in other sectors and that there is a very unequal and concentrated structure of ownership. This may cause an underclass of landless former agricultural workers who are left over in farming, and who cannot get jobs in the other sectors. It implies that a restrictive land legislation may be needed from both a social and a regional point of view.

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