Did higher inequality in agriculture enhance productivity?  
The case of Cisleithania, 1902

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From 1867, when Cisleithania was created, to World War I, the population of this part of Austria-Hungary grew from 20 million to 29 million inhabitants. The share of the agricultural population decreased from about two thirds to slightly below 50 per cent but remained more or less constant in absolute terms. The agricultural labour force remained constant in absolute terms as well. In the same period the agricultural production rose from 19 million tons of grain value to 33 million tons, which amounts to a 56 per cent increase of output per agricultural worker, that is, little more than 1 per cent annually on average. The increase per head of the population was 26 per cent, that is, close to 0.6 percent annually.

The occupation statistics are not consistent throughout the period, and many people pursued mixed occupations in agriculture and elsewhere. But the data are good enough to reveal essential features and time trends: While the country was backward from the beginning, and change happened slowly, population gains resulted in increases of the other sectors not agriculture, and the country was able to generate its own nutritional basis, and an ever stronger one at that.

The state, officially called 'The Kingdoms and Lands Represented in the Imperial Assembly', sometimes also 'Austria', and unofficially known as 'Cisleithania', was the non-Hungarian part of the former Austrian Empire (1804–1867), which became the Austro-Hungarian Monarchy in 1867. It was extremely heterogeneous in economic terms but also in terms of ethnicity, religion, educational level, family structures, and the natural environment. It comprised regions as diverse as the Viennese agglomeration and its surroundings, a major industrial and high income centre by contemporary standards, and Galicia with its underdeveloped agriculture, low income and little success in catching up. Cisleithania is usually divided into the Alpine lands in the center (largely today's Republic of Austria), the Bohemian or Sudetes lands in the north (corresponding to the Czech Republic), the Karst lands in the south (Slovenia, and parts of Italy and Croatia), and the Carpathian lands in the northeast (parts of Poland, Ukraine, and Romania) (Map 1). Across these regions, we observe different levels of agricultural productivity as well as different arrays of agricultural products, different patterns of land-holding, different patterns of occupation, and so on.

This paper examines the effects of inequality in agriculture on agricultural productivity in the context of these highly variable regional conditions. It tests two contradictory hypotheses:

1. A higher degree of inequality promoted productivity because large estates were better able to make use of technological advances such as machinery, more sophisticated fruit rotation systems, and more flexible use of manpower. They profited of economies of scale and stronger market integration. Very small farms, on the other hand, were intensely cultivated and therefore relatively productive as well. This was possible because these farms were actually run by the owners and their family
members only who did not earn wages but lived off their product, used their land more intensely, and tended to exploit themselves.

2. A lower degree of inequality promoted productivity because in medium sized estates the owners were the actual operators, and some of the farm labourers were the owners’ relatives, which raised operators’ and employees’ commitment to farms and output. Generally, in medium sized farms the proportion of wage labour was lower than in large estates. In these farms, labourers (family members and unrelated workers alike) usually lived on the farm not in their own houses, which facilitated control over their doing, and helped to enforce work discipline.

In the literature, the relationship between farm size and size distribution on the one hand, and productivity on the other, has been discussed in the context of development economics as well as economic history. One topic was economies of scale, whose absence would be an argument in favour of land reform and ceilings on farm size. However, the results are not uniform. A study on Pakistan (by regions and crops) in the 1970s suggests mostly constant returns on scale, in one case increasing returns, in another case decreasing returns (Khan 1977). Technology and the mode of operation (by owners or by managers) affect the outcome. A comparative analysis of developing countries in the 1970s arrived at the conclusion had higher yields per hectare due ‘to higher factor inputs and to a more intense use of land,’ not due to decreasing returns to
scale (Cornia 1985). The historical literature discussed market integration as well as technological aspects (Kander and Warde 2011; Kopsidis and Wolf 2012).

The paper is organised as follows. Section I estimates the productivity of Austrian agriculture in 1902 in a regional perspective. Section II compares various estimates of land distribution. Section III provides descriptive statistics of various other factors for productivity. Section IV estimates the impact of land distribution and the other factors and puts the result in relation to the initial assumptions and the findings in the literature. Section V sums up the results.

I

The differences in agricultural productivity across Cisleithania were enormous (Map 2). In this study, productivity is defined as the average production in crowns per labour unit in a given district. Across all regions, the average district had an agricultural production of close to 400 crowns per labour unit in 1902.

On the level of lands, Lower Austria was most productive, followed by Bohemia, Upper Austria, Moravia, and Carinthia. Least productive was the Littoral, followed (in ascending order) by Dalmatia, Galicia, Bukovina, and Carniola. On the level of smaller regional units, western Bohemia (around Cheb) was most productive, followed by
Upper Styria and Lower Austria (Upper Styria was just a small part of Styria, which is why Styria as a whole did not perform particularly well). Thus, generally speaking, all southern territories (including even southern Tyrol), and all north-eastern ones, performed badly, with a production per labour unit in the range of 150 to less than 300 crowns on an average, whereas the major part of the Alpine lands, and the Bohemian lands, did very well and managed an average production in the range of 450 to 580 crowns.

These differences cannot be explained by the regional specialisation. Of course, the proportion of various products (meat, milk, wool, grain, wine, other crops, wood) in the overall product differed between regions (although most regions tried to produce at least a minimum of everything). But the regional focus on one product group or another does not explain overall output per worker. For instance, highly productive Lower and Upper Austria, Bohemia, and Moravia, had a focus on grain and other crop production, but so had Galicia as well. Livestock breeding was particularly important in an area more or less identical with the mountain range of the Alps, which productive regions such as Upper Styria, Salzburg, and the well-performing parts of Carinthia and the Tyrol, but also less successful part of Carinthia, the Tyrol, and Vorarlberg. Wine-growing was very important in the altogether little productive southern regions, such as Dalmatia, the Littoral, southern Styria, and southern Tyrol, but also in very productive regions such as major parts of Lower Austria, and southern Moravia. If specialisation had any
relevance for overall productivity, it was probably rather a sign of regional weaknesses: Regions that managed to produce a range of different products were more successful than regions with a heavy focus on one product group. For instance, Upper Styria, which was not particularly favoured climatically, combined a major meat production with milk and wood production; Lower Austria was a strong grain producer, but produced also other crops successfully in the region east of Vienna, was a major wine producer, a medium sized milk producer, and a strong producer of pork along with beef.

Part of these results is caused by the environment: Cattle breeding was the best thing to do in the mountains, and wine-growing was the best option for the southern lands. Other potential factors include labour supply, technology, energy, and the inequality in the land distribution prevailing in a given region.

II

Inequality in agriculture might be conceived as inequality in income or wealth in the agricultural population. Since this study investigates the impact of inequality on productivity, it would make sense to use the distribution of operating assets among agricultural holdings. Unfortunately, there are no comprehensive statistics of these assets in a comparative perspective throughout Cisleithania. However, a study of wealth
on the household level reveals that land accounted for more than 90 per cent of agricultural wealth of any kind) (Pammer 2001). Therefore, clearly the distribution of land is the crucial element of agricultural inequality.

The distribution of land is documented in the agricultural census of 1902. The census provides statistics of overall land, productive land, agricultural land, forests, fields and meadows, and so on, for every political district. Each statistic contains a classification of farms according to the area of their land, so that we know the number of farms with, for instance, an agricultural area below 0.5 hectares, 0.5–1 hectares, 1–2 hectares, and so on. In this study agricultural inequality is inequality in the distribution of agricultural land.

Clearly the information resulting from these statistics is far from perfect. The productivity and value of agricultural land depends heavily on the kind of cultivation that it allows – obviously the productivity of a vineyard in a wine-growing region differs very much from the productivity of a pasture in the alpine mountains. Therefore, for the aim of this study, it would be preferable to categorize farms according to the value of their land. This was impossible to do in the 1902 census (it appeared difficult enough to arrive at a consistent assessment of acreage across different regions and their different measurement systems); however, we can at least correct for geographic and environmental conditions which may have influenced productivity independently.
The classification of agricultural holdings can be used to calculate various measures of inequality, depending on the form of the distribution. Assuming a lognormal distribution, which is usually found in studies on wealth, we can calculate Gini coefficients from grouped observations (Map 3). Alternatively, in a more complex approach, we can identify different four types of land holding defined along size and the form of the distribution (Map 4). Another alternative is the straightforward calculation of the proportion of either medium sized farms or very small/very large farms in all agricultural holdings (Map 5 and Map 6) (for the three approaches, see Appendix 1).

The Cisleithanian average is represented best by regions including most of Bohemia and Moravia, Bukovina, the Lower Austrian wine-region, parts of Tyrol, Middle and Lower Styria, and the Karst lands. The Gini coefficient is in the medium range (0.63 on average), and up to farm sizes of 20 hectares, the proportion of the size classes in the total deviate very little from the Cisleithanian average. The highest size classes, however, are underrepresented. The median size is typically the same as in the whole of Cisleithania as well. 42 per cent of all districts belong to this type. In our classification, this is Type 1.

The largest contiguous region with a particularly egalitarian distribution of agricultural land was almost identical with Galicia. Galicia had a relatively low Gini coefficient (0.58 on average), a large proportion of medium sized farms (particularly those between 2 and 5 hectares), and a low proportion of very small/large farms; in
Galicia, there were very few farms with less than 0.5 hectares, or with 10 to 50 hectares, and the proportion of very large estates was in the middle range. A similar distribution can be found in some smaller regions such as eastern Styria and western Tyrol and adjacent Vorarlberg. Characteristically, these are borderland regions: eastern Styria borders on Hungary and show similarities with the neighbouring West-Hungarian regions; western Tyrol and southern Vorarlberg border to the Swiss Canton of Grisons and share many features of land distribution, inheritance patterns, family structures with it. 24 per cent of all districts belong to this type. The median is slightly above average in this type of districts. In our classification, this is Type 2.

In major parts of the Alpine lands, particularly in Upper and much of Lower Austria, Salzburg and adjacent Tyrolian districts, Carinthia, parts of Styria, and southern Moravia, the Gini coefficient is in the middle range (0.64 on average), but otherwise the patterns of distribution are quite different from the average. In these areas, all farm sizes above 5 hectares, and particularly those above 10 hectares, are overrepresented, smaller holdings are accordingly underrepresented. The median is much larger than the Cisleithanian average. 20 per cent of all districts belong to this type. In our classification, this is Type 3.

Trentino, parts of Dalmatia, and scattered districts in the Alpine and Bohemian lands show quite different patterns of land distribution again. The Gini coefficient is highest in these regions (0.70 on average). Farms up to 1 hectare are heavily
overrepresented, and those above 2 hectares are underrepresented. The median size is far below average in this type of district. 14 per cent of all districts belong to this type. In our classification, this is Type 4.

III

Clearly the size distribution of land cannot be expected to be the only factor determining agricultural productivity. Hypothetically, we may assume that factors such as family structures, working conditions, capital, and climate, may have influenced the outcome as well. In part, these factors are associated with farm size and therefore with the distribution of land.

In agriculture, family structures and working conditions were closely interrelated. The personnel of farms consisted of farm owners, their relatives, farm workers living on the farm year-round, day labourers, and itinerant workers. The proportions of these categories depended on the size of farms, on the family cycle (that is, the generational change within farms), on the main products and the typical production process, and on cultural factors (that is essentially, family structures typical for the respective regions); indirectly, ecological factors were relevant insofar as they determined production and the necessary factor input. The average number of people working on a farm differed
considerably between regions (Map 7). Larger farms which required more workers could fulfil their demand by employing relatives, or by employing unrelated persons; the predominant solution was very much a result of cultural patterns that determined the proportion of simple-family households on the one hand, and multigenerational households, frérèches and other complex forms on the other. The employment of servants living in the house year-round was often a life-cycle matter, with changing roles of owners’ children and unrelated servants, and different degrees of mobility. Microstudies reveal that the solutions were flexible, and patterns would change quickly even on the local level (Mitterauer 1990). Clustering districts using the proportions of various categories of personnel yields a clear regional pattern with three main types as shown in Map 8:

- One type (‘Servants type’) is characterised by a particularly large proportion of farms with servants living there year-round. 38 per cent of the farms on average employ such servants. In addition, 6 per cent of the farms employ day-labourers, and 13 per cent employ itinerant workers. 18 per cent are run by the owners alone, 33 per cent are run by owners and family members together. This type is particularly common in the eastern Alps lands and overlaps very much with the bimodal type of land distribution, that is, with an area of a relatively large proportion of major farms which employed much personnel.
The second type ('Owners only') is characterised by a large proportion of farms (30 per cent on average) that were run by the owners alone and without any other workers. Since an additional 44 per cent are run by owners and family members together the vast majority of farms in these regions are family farms. The average farm in these regions was small and the average number of employees was relatively low. Therefore, only 15 per cent of the farms employ servants living in the house, 3 per cent use day labour, and 11 per cent itinerant workers. As might be expected, this type is more common in regions with relatively small farms such as the Bohemian land, in western Tyrol and Vorarlberg, and parts of Dalmatia.

The third type ('Family members') is characterised by a very large proportion (74 per cent on average) of farms that were operated by owners and family members together. Since an additional 11 per cent were run by the owners alone the role of persons from outside the family is quite limited; only 10 per cent of farms employ servants living in the house year-round, 2 per cent use day labourers, and 4 per cent use itinerant workers. The average number of employees on the farms in these regions was not particularly small, though not as large as in the mountain regions of the Alps. This type is most common in the area of the Eastern European family forms, where the proportion of
multigenerational households, multi-family and complex family households is high, that is, in the Carpathian lands, and the Karst lands.

Working conditions and labour supply have to consider that many people in the pre-World War I economy pursued mixed occupations. The decennial censuses list both main occupations and by-occupations, and the agricultural census informs about by-occupations of the agricultural population in detail. By-occupations may be supposed to have played a major role for agricultural productivity because they offered an additional option for small agricultural land holders. As pointed out at the beginning, very small land holders may have been particularly productive for the simple reason that they had to exploit themselves in order to earn an income sufficient for subsistence. If that was so, a large proportion of very small land holders would have led to a high degree of productivity. If, however, small land holders had an alternative to self-exploitation in agriculture by way of a by-occupation in, for instance, manufacturing, this would have lowered productivity in this size class of farms. Generally, by-occupations were significantly more frequent in small farms: Both the size of farms in terms of acreage and their size in terms of labour units per farm have a highly significant negative effect on the number of by-occupations pursued per farm. The rates of by-occupations were low in the Alpine lands, and high elsewhere (Map 9): In Galicia and in the south, the preferred kind of by-occupation was dependent labour in agriculture; in Bohemia was a variety of dependent labour in agriculture, dependent or independent labour in
industry, or work in cottage-industry. The limited extent of by-occupations in the Alpine lands was mostly work in industry, particularly independent work.

Considering the technological level and energy input, we find large differences within the area. The main energy source, apart from human labour, was the use of draught animals mainly in crop production and forestry. Their impact on productivity has been questioned in the recent literature on the European agriculture in the nineteenth century, other studies have found a positive impact of horses (per area) on productivity (Kander and Warde 2011; Kopsidis and Wolf 2012). Draught energy input is measured in horse-powers of all animals actually used for draught, put in relation to the number of workers. Therefore one might expect less energy input of this kind in the typical livestock production areas. In fact, this is true, with the exception of those parts of the centres of livestock production where forestry was important indeed, which is the case in parts of Carinthia and Styria (Map 10). Otherwise, the areas with the heaviest use of draught animals were Upper and Lower Austria, and East Galicia. The exact opposite is Tyrol and Vorarlberg with their focus on livestock and particularly on milk production.

Another factor relevant for productivity might be the use of machines. On the whole, one in three farms used any machines such as chaff-cutters, cleaning and sorting machines, and a variety of less common machines. The use of machines was most common in the Bohemian lands, in some parts of the Alps, in Upper and Lower Austria,
and in eastern Styria. In the Carpathian lands, but also western and southern Tyrol, Vorarlberg, and all lands in the south, most farms did without machines (Map 11).

Environmental conditions have clearly an impact on productivity. They determine the yield by hectare in crop production, and consequently, the focus on various crops, or on livestock. This is true even around 1900 when the share of subsistence production in the Cisleithanian agriculture was still quite high, and the degree of specialisation accordingly limited. Apart from the quality of the soil, climate factors are particularly important in this context. Detailed data on temperature and precipitation on the level of political districts are not available for this period. Therefore, this study uses two proxies instead: 1. The geographical altitude of the district is closely associated with climate factors so that a higher altitude will probably lower the yields in crop production (Map 12). 2. The relation between the overall production and the yields per hectare in wheat and rye production. Basically, regions with relatively higher yields in wheat production can be supposed to have warmer and drier climate. However, there are caveats because most regions produced at least some wheat although rye was clearly the more important bread cereal in terms of quantity. In regions with a less favourable climate, wheat production was certainly concentrated on the best location, which may blur differences in yields per hectare.

Finally, a study on productivity in a given district should consider productivity in neighbouring districts as well. The assumption is, a higher productivity in surrounding districts will coincide with higher productivity in the district under investigation. The relationship may be regarded in part as causal, in part as merely correlative. The causal relationship might be interpreted as the result of an exchange in skills, technological expertise, and similar factors; the correlative relation considers that some factors relevant for productivity have certainly been omitted either because they have been overlooked or due to a lack of data.

IV

In order to explain regional differences in productivity using the factors discussed so far, we start with bivariate models including just the distribution measures as independent variables (the results are not shown in the tables). The results suggest that the first hypothesis mentioned at the beginning of this article might be more appropriate than the alternative hypothesis: Generally, a higher Gini coefficient has a highly positive effect on productivity; likewise, a larger proportion of medium sized farms has a negative effect on productivity; and, compared with Type 1 districts such as those most common in the Bohemian lands, Type 2 districts with a more equal distribution (as typical for Galicia) are significantly less productive, and Type 3 districts are significantly more productive. Type 4 districts, however, are significantly less productive as well.
Factors for agricultural labour productivity

<table>
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<tr>
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<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
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<tbody>
<tr>
<td>Intercept</td>
<td>-136.80 (61.89)*</td>
<td>39.77 (31.28)</td>
<td>485.45 (53.88)**</td>
<td>144.91 (34.66)**</td>
</tr>
<tr>
<td>Productivity in</td>
<td>0.64 (0.05)**</td>
<td>0.57 (0.05)**</td>
<td>0.52 (0.05)**</td>
<td>0.59 (0.05)**</td>
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<tr>
<td>neighbouring districts</td>
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<tr>
<td>Gini coefficient of</td>
<td>414.24 (95.29)**</td>
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<tr>
<td>agricultural land</td>
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<tr>
<td>distribution</td>
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<tr>
<td>Farms &lt; 0.5 ha or &gt; 20 ha</td>
<td>618.64 (74.55)**</td>
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<tr>
<td>Farms 1–10 ha per all farms</td>
<td></td>
<td>-504.04 (57.06)**</td>
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<td>Type2 distribution</td>
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<tr>
<td>of land (lognormal, low variance)</td>
<td></td>
<td>-73.68 (16.20)**</td>
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<td>Type3 distribution</td>
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<td>of land (‘bimodal’)</td>
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<td>Type4 distribution</td>
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<tr>
<td>of land (‘Pareto’)</td>
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<tr>
<td>Median farm acreage</td>
<td>103.13 (15.67)**</td>
<td>166.55 (17.35)**</td>
<td>144.41 (15.54)**</td>
<td>111.59 (17.80)**</td>
</tr>
<tr>
<td>Share of farms with</td>
<td>118.51 (56.94)*</td>
<td>54.84 (54.02)</td>
<td>21.74 (54.00)</td>
<td>33.31 (56.82)</td>
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<tr>
<td>owner workers only</td>
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<tr>
<td>By-occupations per</td>
<td>11.27 (33.50)</td>
<td>45.10 (31.86)</td>
<td>46.23 (31.51)</td>
<td>47.62 (32.83)</td>
</tr>
<tr>
<td>farm</td>
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<tr>
<td>Share of farms using</td>
<td>80.36 (40.87)*</td>
<td>102.97 (38.56)**</td>
<td>101.37 (38.11)**</td>
<td>99.67 (39.69)*</td>
</tr>
<tr>
<td>machines</td>
<td></td>
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<tr>
<td>Draught animals, kW</td>
<td>20.93 (95.30)</td>
<td>-139.69 (92.09)</td>
<td>-152.14 (91.22)</td>
<td>21.45 (98.71)</td>
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<tr>
<td>per labour unit</td>
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<td>production in overall</td>
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</tr>
<tr>
<td>production</td>
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<td></td>
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<tr>
<td>Altitude</td>
<td>0.04 (0.04)</td>
<td>0.01 (0.03)</td>
<td>0.01 (0.03)</td>
<td>0.04 (0.03)</td>
</tr>
<tr>
<td>Adj R²</td>
<td>0.75</td>
<td>0.78</td>
<td>0.79</td>
<td>0.77</td>
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<td>N</td>
<td>376</td>
<td>376</td>
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<td>376</td>
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</tbody>
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Sources: see Appendix 2

Notes: All variables are mean values for districts. Agricultural productivity = agricultural production per labour unit. Productivity in neighbouring districts = mean value of productivity in adjacent districts. Type 2 to Type 4 distribution: see Appendix 1. Share of farms with owner workers only: share of farms without employment of relatives or unrelated employees. Values in parentheses are standard errors. *, **, *** = significant at the 5, 1, and 0.01 per cent level.

The inclusion of other factors underlines the impact of the distribution variables. The Gini coefficient keeps a robust and highly significant positive impact on productivity. The same is true for the combined proportion of very small and large farms (that is, an unequal distribution). Accordingly, a large proportion of medium sized farms has a highly significant negative effect on productivity.

The classification of districts along the proportion of size classes yields a result pointing to the same direction: Compared with Type 1 districts, Type 2 districts are significantly less productive, and Type 3 districts are more productive. Type 4 districts are much more productive as well. Although the latter result is in line with the other
findings (Type 4 districts had a particularly unequal distribution), it is still surprising
given the fact that generally Type 4 regions do not appear as very good performing
producers.

The reason lies in the model specification, which includes median farm size as an
independent variable. The results suggest that generally larger farms were more
productive, which means that the positive effect on productivity caused by a higher
degree of inequality due rather to the large share of major farms in such a distribution
not to the large share of very small farms. Therefore, if the size factor is accounted for,
Type 4 districts (which have a large share of small farms) appear as quite productive. If
the size factor is omitted, Type 4 districts do not differ significantly from Type 1
districts in terms of productivity. In such a setting, however, the other inequality
measures keep their sign and have still a significant effect (not shown in the tables).

Some of the other factors discussed above have little or no impact on productivity.
The composition of the labour force has some effect, but is quite sensitive to
modifications in the models. In some models (not shown in the tables), the share of
family farms employing relatives, or farms employing unrelated servants year-round,
have some effect that disappears in a different setting. The reason is, the composition of
the labour force is closely associated with other independent variables. By-occupations
have no effect, either. Special varieties of by-occupations (for instance, by-occupations
in industry) yield effects that are due to correlations between independent variables
again. The basic assumption, however, was that by-occupations of any kind offer an
alternative to more intense agricultural work in small farms; the results suggest no such
effect.

Concerning energy and technology, we find a significant effect of the use of
machines on productivity; the effect is not particularly strong, but fairly robust and
plausible. The use of machinery was more common in larger farm, which means that
some of the effect of technology on productivity is already contained in the median farm
acreage variable. Therefore, omitting farm size from the models raises the effect of the
machine variable (not shown in the tables). Concerning draught energy, a more intense
use of draught animals seems to have not raised productivity. The results hold even if
unproductive Galicia with its heavy use of draught power is excluded from the analysis
(not shown in the tables). Similar to machine use, draught power was used more
intensely in larger farms. Therefore again, it has a significant impact on the result if we
omit the farm size variable from the models. Otherwise, the reason for this relative
irrelevance of draught animals for productivity lies in the fact that there were so many
different kinds of production apart from those requiring draught power. Doing the same
analysis for grain production (instead of overall production) shows a highly significant
positive effect of draught power on productivity (this is somehow trivial because in
regions which produced less grain and used less draught power much of the labour
input was simply used for different productions).
The share of livestock production in overall production was negatively associated with productivity. This should not be interpreted as a causal relationship. Livestock production in itself did not lower productivity, but livestock production was the relatively best solution in areas which offered unfavourable conditions because they were at high altitude, had a harsh climate and low crop yields. In the context of this study, the share of livestock production may be interpreted as a proxy for environmental conditions, together with altitude and harvest data. Among these variables, livestock production proves to offer much the strongest impact in the models. As might be expected, omitting the livestock variable from the models lowers the impact of the distribution variables a bit because livestock production was more important in areas with an unequal land distribution. However, even in such a setting the inequality measures exert still a significant impact in same direction as described above.

As is always the case in geographical analyses of this kind, the spatial autoregressive term has a highly significant impact on the result. Omitting it from the models would, of course, increase the impact and significance of the other variables.

In order to evaluate the sensitivity of the results to regional particulars, the same analyses were done excluding parts of Cisleithania, notably Galicia. Since Galicia is so large and has obviously very special conditions in almost every aspect of agricultural production, it might be suspected that the observed relation between inequality and productivity is in reality just a matter of Galician peculiarity. However, the results prove that this is not the case. In models excluding Galicia (or both Carpathian lands) the impact of the inequality measures (except the classification measure which requires the Galician districts systematically) stays the same in size and direction, and even in significance although the sample is smaller. The same is true for models estimated just for all Alpine and Bohemian lands (excluding both the Carpathian and the Karst lands), that is for the more advanced part of the Cisleithanian agriculture. Similar to the other findings, in these models a higher degree of inequality in the distribution of agricultural land has as significantly positive effect on agricultural labour productivity.

This study offers a reasonably safe answer to the research question put at the beginning: Did a higher inequality in the distribution of agricultural land exert a positive or a negative impact on agricultural labour productivity, or no impact at all? The findings suggest that a higher degree of inequality raised productivity indeed. This effect is primarily due to the role of larger farms which used machines and draught power more intensely and may have enjoyed additional advantages like easier market access, or economies of scale. Very small farms seem to have contributed less to the productivity success in the less egalitarian regions.
However, the role of very small farms is remarkable in another sense. These farms were likely to pursue an additional occupation elsewhere in order to increase the household income. The data prove that this was the case indeed and that by-occupations of various kinds were typical precisely for the small and very small farms. This means that small farms dedicated part of their labour resources to production unrelated to their own business, and partly to production outside the regional agriculture. In spite of this mixed occupation, by-occupation had no negative impact on agricultural productivity. The conclusion is, very small farm owners may have exploited themselves as suspected at the beginning, but the result may be visible in industrial or service production rather than in agriculture.

It should be underlined that the results presented in this paper cannot simply be attributed to regional peculiarities in a highly heterogeneous country. Although the Cisleithanian economy and society was extremely heterogeneous indeed, the analyses conducted for the whole state yield essentially the same results if they are restricted to parts of the country which display a far higher degree of homogeneity and which represent essentially the upper half of the productivity distribution. It seems that higher inequality in agriculture did actually enhance productivity.
APPENDIX 1: DISTRIBUTION ESTIMATES

In this paper, the distribution of agricultural land is measured in three different ways in order to control for the respective weaknesses of these approaches.

The first measure is the Gini coefficient, which informs about the overall level of inequality and has the advantage of simplicity. Its disadvantage lies in its disregard for the specific form of a distribution – quite different distributions can represent the same overall level of inequality, and will therefore yield the same Gini coefficient.

In the case of the present study, the Gini coefficient cannot be calculated using single cases, but has to be calculated from grouped observations as displayed in the official sources. A prerequisite of doing so is the assumption that the variable to be investigated (that is, the acreage of farms in a given region) is normally distributed. Wealth or income are usually lognormally not normally distributed; therefore calculations are done using logarithms.

In the 1902 agricultural census, which was used as a source for this study, the size of land holdings is displayed in size groups; all farms are contained in the census. Therefore we know the proportion of farms smaller than 0.5, 1, 2, 5, 10, 20, 50, and 100 hectares. Since the distribution is supposed to be lognormal, these values are converted into their logarithms.

In a normal distribution the proportion of the population below a given threshold is precisely defined and can be converted into the number of standard deviations between the mean and the respective threshold. Since the proportion of farms with an acreage of, for instance, 0.5 hectares or less, will differ between districts, the same will be true for the number of standard deviations between the median acreage and a size of 0.5 hectares. If, for instance, in a given district exactly 5 percent of all farms are smaller than 0.5 hectares, this means that in this district the distance between the median acreage and an acreage of 0.5 hectares is 1.96 standard deviations.

Thus, every district has its own relation between the size class thresholds and the corresponding numbers of standard deviations depending on the proportion of the respective groups in all farms. This enables us to estimate the following regression equation for each district:

\[ \ln(A_u) = \mu_{\ln A} + \sigma_{\ln A} \cdot q \]

where \( A_u \) denotes the upper limit of a farm size bracket, and \( q \) is number of standard deviations between \( \ln(A_u) \) and the mean of the log-distribution of acreage. These are the observed values (\( A_u \) is taken directly from the census tables, and \( q \) is the result of the conversion described above). \( \mu_{\ln A} \) is the constant, and \( \sigma_{\ln A} \) is the coefficient, to be estimated in the regression. At the same time, \( \mu_{\ln A} \) is both the arithmetic mean and the median of the log-distribution of acreage, and therefore the median of the original (not
logarithmised) distribution, and $\sigma_{lnA}$ is the standard deviation of the log-distribution. These estimates can be converted in other measures like variation coefficients or Gini coefficients (Aitchison and Brown 1969).

As pointed out, this approach relies on the assumption that farm land was distributed lognormally. In fact, this assumption comes reasonably close to reality in many districts but not everywhere, as becomes visible in the following alternative approach.

This approach involves a classification of districts. The advantage of this approach lies in the more complex information that comes with categorisation. The variables used for classification are the proportion of farms in each of nine size classes in every district again. Clustering was done using the squared Euclidean distance and the Ward method, which tends to produce clusters with minimum variance. The approach yielded the four types of size distribution described in the main text:

- **Type 1 (average):** In a number of districts, the distribution was close to lognormality with a high variance. In terms of the overall inequality, the proportion of size classes in the total, and the medium size of farms, this type resembles very much the average of the whole of Cisleithania.

- **Type 2 (low variance):** In the second type, the distribution was close to lognormality as well, but the variance is smaller, and the proportion of middle-sized farms in the total is above average. The medium size of farms is not much above average.

- **Type 3 (bimodal):** Other districts show a bimodal distribution, typically with one mode in the range of 2–5 hectares, and one in the range of 10–20 hectares. The proportion of large farms, and thus the medium farm size, is above the Cisleithanian average.

- **Type 4 (‘Pareto’):** The third type of distribution show the largest numbers of farms in the lowest size classes; the proportion of farms above 2 hectares is far below average, and medium farm size is far below average as well. The numbers of farms do not decrease monotonically with size, but typically the distribution has a mode around 2 hectares. The distribution resembles the sum of a Pareto distribution and a lognormal distribution.

This categorisation of districts is used as an alternative measure of distribution, with three dummy variables for Types 2–4 in the equation, and Type 1 serving as the reference group. Although the categorisation involves information that is not contained in the Gini coefficients, and in spite of the deviation of lognormality in Type 3 and Type 4 districts, the overall pattern of land distribution is quite similar according to both measures, and the fit of the regressions used to estimate Gini coefficients is not necessarily bad even in the districts of the bimodal or Pareto type. The $R^2$ is above 0.93 practically everywhere, and above 0.99 even in a number of (Type 3) Alpine districts.
A third measure of inequality used in this study is simply the proportion of farms falling upon a characteristic selection of size groups. As might be expected, the proportions of size classes are closely correlated with the estimated Gini coefficients: In bivariate regressions, the proportion of the smallest size group (less than 0.5 hectares), and the proportions of the large size groups (20–50, 50–100, above 100 hectares), are each positively correlated with the estimated Gini coefficients, and highly significantly so. The proportions of the four size groups between 1 and 10 hectares show a highly significant negative correlation with the Gini coefficient. We use therefore two proportional measures of distribution alternatively:

- the proportion of all farms sized 1–10 hectares (‘medium sized farms’), assuming that a larger proportion of these farms in the number of all farms indicates a lower degree of inequality;
- the proportion of all farms sized either less than 0.5 hectares, or more than 20 hectares (‘very small/very large farms’), assuming that a larger proportion of these farms in the number of all farms indicates a higher degree of inequality.

The advantage of these measures lies in their simplicity and in the fact that their calculation does not require a special form of the distribution (such as a normal or lognormal one). The disadvantage is their sensitivity to special regional conditions.

In spite of the generally close correlation between these measures and the Gini coefficients, the regional patterns produced by them are not identical. The most important differences lie in the estimates for the regions with the Type 3 (bimodal) distribution. In these regions, the proportion of farms sized 1–10 hectares is particularly low, which would normally be understood to indicate a high degree of inequality. But in the Type 3 regions, the small proportion of those farms is merely a result of the fact that all small farms are underrepresented, and farms are generally larger. For the same reason (the underrepresentation of the smallest farms) the proportion of ‘very small/very large farms’ is relatively small in these regions.

Although each of these measures has its drawbacks, the results are remarkably consistent. Using either the Gini coefficient or the classification of districts or the proportion of aggregated size groups as factors for productivity we arrive essentially at the same results.

APPENDIX 2: DATA

The data used in this paper are taken from various official statistics. The main source for the independent variables was the agricultural census conducted by the Austrian Statistical Office in 1902. This census recorded all agricultural holdings in the country without exception. It informs about the size of farms, types of cultivation, personnel, machinery equipment, livestock, and numerous other items. Most variables are broken
down by the size of farm holdings, and by the type of cultivation (such as the proportion of arable land and meadows, forest, gardens, and others).

The 1902 census is also the basis for part of the production estimates because it lists livestock in much detail. Therefore meat production, milk production (from cows, goats and sheep), and wool production were estimated using these data.

In addition to the census data, the Ministry of Agriculture produced annual harvest statistics, which provide information on the main cereals and on a number of other products both by area and by output. In the production of cereals, quality can be accounted for because the statistical publications indicate regional numbers of the marketable and not marketable shares of the harvest in combination with regional prices. For this study, the effective value of the harvest was used.

Grain data are available on the level of political districts (and even court districts, which were smaller units), that is, they can be linked directly with the agricultural census data. Other crops are available on the level of 104 so-called ‘natural regions’. One of these ‘natural regions’ had the size of three to four political districts on average. In order to estimate the share of a political district in the remaining crop production (except grain) of a ‘natural region’, it was assumed that the relation of grain production to other crop production in a ‘natural region’ was the same in all districts (or parts of districts) belonging to the region; crop production was divided up accordingly among the participating districts. The result is a crude estimate because ‘natural regions’ were certainly not perfectly homogeneous production areas. However, given the fact that ‘natural regions’ were defined along the lines of the natural environment, which had a major impact on production, the approach seems defensible.

All crop production estimates except wine production were conducted on an annual basis. Since crop production fluctuates heavily from year to year, the numbers used in this study are five-year averages from the period 1900–1904 (however, the results differ little if just the 1902 numbers are used).

Wine production data are available on the district level for 1895 latest. Later yearbooks contain data on the level of ‘natural regions’, but in this highly specialised production a direct use of district data is preferable in spite of the time lag and the disadvantages of using data of a single year. Therefore, this paper uses the data from 1895.

Estimates of all products in terms of grain value are based on Sandgruber (1978).

Geographical altitude was calculated using the altitudes of all towns that were seats of a court district. The altitude of a district as defined in this paper is the average altitude of those court seat, weighted by the size of the population of the respective court district.
SOURCES


REFERENCES


