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Rural Reforms, Agricultural Productivity, and the Biological Standard of Living in South Korea, 1941-1974

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No. 106

**Rural Reforms, Agricultural Productivity, and the
Biological Standard of Living in South Korea, 1941-1974**

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Rural Reforms, Agricultural Productivity, and the Biological Standard of Living in South Korea, 1941-1974

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Abstract:

This paper analyzes effects of the Republic of Korea's two major rural reforms in 1950 and 1962/63 on agricultural productivity and individual well-being. The 1950 Land Reform resulted in a large-scale redistribution of land while 'green revolution'-type reforms in 1962/63 pushed forward the application of modern agricultural technologies and improved rural infrastructure. This study's findings indicate that both reforms had significant positive impacts on agricultural productivity. Using the link between final height outcomes and early childhood nutrition further allows an assessment of the effects of the interventions on the biological standard of living using adult height outcomes. Korean mean adult height grew by a remarkable 8.1 to 12 cm for women and 7 to 9.6 cm for men born between 1920 and 1987. Two thirds of this growth took place after the 1950 reform, and about 40 to 50 percent after the 1962/63 reforms. Structural break analyses of height trends reveal significant upward shifts in trend around the years of the reforms. While Korea can be considered a case of successful land reform, the years between the two major reforms can be considered Korea's lost decade.

JEL: Q15; N35; O13

Keywords: Land Reform; Rural Technological Reforms; Agricultural Productivity; Biological Standard of Living; Equity-Efficiency.

1. Introduction

The World Development Report 2008 once again redirected the focus for development policy and poverty reduction efforts to the rural economy, accruing from the fact that the majority of the world's poor at the beginning of the 21st century still resides in rural areas. It argues that sustainable rural income growth and poverty reduction requires improvements in agricultural productivity, a general empirical finding in the literature (e.g. Datt and Ravallion, 1998; Ravallion and Chen, 2007; Deininger, 2003; Grimm, Klasen and McKay, 2007; Minten and Barrett, 2008). It further states that both an equitable land distribution and agricultural production technologies are key factors for attaining sustainable growth in the rural economy. Moreover, these can lay the basis for industrialization and equitable growth of the whole economy, as has been seen in the extraordinarily successful East Asian NICs.

In the short run, a more equal land distribution translates into both lower average farm size and higher rates of ownership. By redistributing land to the actual tillers, strong incentive effects can be set free. As long as feudal or semi-feudal land structures pertain, with few landlords who own most of the land and many landless and land-poor wage laborers or tenants, cultivation is often less efficient and land productivity remains low. Usual contracts of hired farm labor or sharecropping are associated with lack of supervision and thus result in lack of incentive and static inefficiencies (Otsuka, Chuma and Hayami, 1992).¹ Moreover, empirical findings suggest that in low-productivity agricultural sectors, farm sizes are often inversely related to agricultural productivity (see e.g. Deolalikar, 1981; Fan Chan-Kang, 2005). In addition to efficiency considerations, ownership rights further enable farmers to access credit, and to increase investment in education and physical capital (e.g. Feder and Feeny, 1991; Deininger, 2003).

That initial asset inequality matters for long-run growth has been shown in the academic literature in several studies (Alesina and Rodrik, 1994; Persson and Tabellini, 1994; Deininger and Squire, 1998; Rodrik et al., 1995; Galor et al., 2009). Theoretical explanations put forward two main channels: On the one hand, credit rationing in the presence of indivisible, economically profitable investment opportunities in education or agricultural technology may lead to underinvestment by the asset-poor. On the other hand, political bargaining power of the asset-poor might be limited and thus also the ability or preference to participate in a democratic process. Therefore, ensuring low levels of asset inequality can

¹ Already in 1975, the World Bank stressed the desirability of owner-operated family farms and the importance of an egalitarian asset distribution as two of its three strategic principles for its land reform policy. Until today, these strategies have not been changed (Deininger and Binswanger, 1999).

foster broad-scale investment into human and physical capital not only on the individual but also on the government level, and therefore significantly enhance long-run growth. Rising overall human capital combined with low social pressure for redistributive policies furthermore facilitates efficient governance and political stability. For all the above mentioned reasons and the undeniable success of the East Asian “low-initial-inequality” growth examples, the formerly widely believed equity-efficiency trade-off, which assumes that inequality is good for growth, is nowadays increasingly put into question.

Besides delivering lower growth, asset inequality does also lead to persistent income inequality even if the country manages to industrialize. In the process of development and structural change in an initially agriculture-based economy, traditional patterns of land holdings are often translated into similarly unequal distributions of productive industrial assets including financial, physical and human capital. That is, in the absence of an initially equitable rural asset base, a limited number of initially wealthy families will then easily maintain their relative political and economic predominance under the new circumstances, perpetuating the country’s unequal income distribution.

Therefore, a redistributive land reform at an early stage of development can be a crucial means to lay the basis for agricultural productivity gains in the short run while enhancing long-run equitable growth and poverty reduction prospects. Such government interventions can lead to both equity *and* efficiency gains. However, history has also taught us that implementing successful land reforms is not a simple task. First, success depends on former land structures, i.e. whether hacienda-like systems prevailed with mainly wage contracts, or tenancy systems with sharecroppers used to run their own businesses. It has often shown to be advantageous if land was distributed to tenants rather than landless laborers, who might find it particularly difficult to become successful farmers. Second, successful land reforms often took place in times of grand political change and were government-led. In many cases, the class of rural landless and near landless found powerful allies in other groups of society, and sometimes even from abroad (Barraclough, 1999). Third, land reforms might yield only limited success if land redistribution is not flanked by productivity enhancing complementary reforms. Such complementary reforms might include improvements in general public infrastructure, better access to credit, improved inputs like new seed varieties, increased supply of fertilizer, extension services, and agricultural R&D. An extensive empirical literature exists that focuses on the effects of agricultural technology adoption and productivity improvements during the Green Revolution. Strongly positive effects on agricultural productivity are usually found from the increased use of fertilizer, improved seeds,

pesticides, and related technical education (e.g. Feder and Umali, 1993). Effective agricultural technology adoption requires government effort and can have pro-poor effects, thus reducing the relative income gap between the rich and the poor (De Janvry and Sadoulet, 2002; Minten and Barrett, 2008).²

South Korea represents an interesting case of land reform since land redistribution and ‘green-revolution’-type reforms can be studied separately. This is due to the fact that they were not enacted at the same time but the latter followed a decade after land redistributions had been completed. Since the government’s objective for the 1950 reform was not the improvement of agricultural productivity but rather the restoration of political stability after turbulent years following liberation, it is possible to isolate relative effects of land redistribution and technology enhancing reforms in Korea (Pak, 1968; Jeon and Kim, 2000). The Korean case is particularly interesting since it represented one of the least developed countries in 1950, with a per-capita GDP level of around the average of the African continent, and an almost complete agriculture-based economy.³ During the following six decades it then went through its well-known growth miracle which lifted the country up to the level of high-income, high-technological OECD economies. In the meantime, Korea managed to hold income inequality at very low levels, with Gini coefficients of income always ranging between of 0.3 to 0.4, initially rising but lately falling again (World Bank, 2004).

The aim of this paper is to shed new light on the still understudied effects of Korean rural reforms on agricultural productivity and individual living standards. Only few papers have estimated the impact of the reforms on the former, making use of macro data, which are scarce particularly for the 1940s and early 1950s. To the best of the author’s knowledge no paper has yet analyzed effects of the reforms on individual well-being using national micro data. This paper takes advantage of the fact that current anthropometric data, or more precisely adult height data sets, can provide good proxies for Korean individual living standards during the midst of the 20th century for which no national-level survey data exists (Komlos, 1993; Komlos and Baten, 1998; Steckel, 1995; 2009; Deaton, 2008; Hoddinot et al., 2008). This paper tries to examine whether and to what extent land redistribution around 1950 and intensification reforms in 1962/63 positively affected agricultural productivity and individual well-being. The findings indicate that both the lowering of land inequality/ increase in ownership cultivation and later technology-enhancing reforms had positive significant

² However, there are also negative sides to the so-called ‘green-revolution’ technologies, for example when exposure to pesticides like DDT lead to increased rates of breast cancer (Clapp et al., 2008), or when monoculture and an overuse of chemicals result in soil degradation (Singh, 2000).

³ Maddison (2003) estimates a level of per-capita GDP for South Korea in 1950 of \$854 (in 1990 International Geary-Khamis dollar) while the average of 57 African countries was estimated at \$889 for the same year.

effects on productivity. Moreover, structural break analyses of time series of adult average height outcomes reveal positive shifts in trends around the years of the rural reforms. Thus, there seems to be evidence for improved food availability resulting from the reforms and an improved standard of living.

The paper is organized as follows: Section 2 gives the reader an overview over background, process and implications of the rural reforms in the Republic of Korea (ROK). Section 3 then analyses the effect of the reforms on agricultural productivity while section 4 examines the effect on individual well-being using anthropometric data. Section 5 summarizes and concludes.

2. Rural Reforms in 1950 and 1962/63

South Korea's government-led land redistribution put into law by the Agricultural Land Reform Amendment Act (ALRAA) in March 1950 is considered in the literature one of the most successful cases of land reform. Before 1950, the Korean rural economy was characterized by a landlord estate system, where few land owners rented out their land to tenants in exchange for a fixed share of their harvest.⁴ Large amounts of farm land were transferred from the rich to the poor as direct or indirect consequences of ALRAA. This changed rural social relations dramatically, leaving former landless and land-poor tenants empowered both economically and politically (Oh, 2008). Equity and democratization gains resulting from the reform are viewed as key to the country's later economic miracle (World Bank, 2004; Rodrik et al., 1995; Boyce et al., 2007). Vested Japanese land had been distributed as early as 1948 under the U.S. military government. After the formation of the ROK Government in August 1948, earlier discussed land reform ideas further progressed and led to voluntary land sales of many Korean landlords already before the actual Land Reform Law (ALRAA). According to the ALRAA scheme, excess land from Korean landlords was then purchased in order to provide it

⁴ In the case of Korea the share rent was on average about 50 percent of "standard production"; depending on the quality of land it could be between 30 and 70 percent (Pak et al., 1966). The reference to "standard production" meant that a tenant had to pay a fixed share of annual standard production rather than weighing the crop each year. This was partly due to the phenomenon of absent landlords, who preferred to live in the cities and thus were not able to continuously monitor farm production. De facto this was coming close to a fixed-rent contract. Thus, tenants were rather bad off in poor crop years and better off in years of good harvest. Contract choice theory tells us that fixed-rent contracts are more efficient than sharecropping contracts in terms of providing maximal incentives. However, poor tenants might often prefer sharecropping arrangements if they are risk-averse and prefer to ensure themselves against bad harvest. In the case of Korea, an additional uncertainty that tenants faced was, as mentioned, the unpredictability of landlords' visits to evaluate "standard production". Thus, some tenants would even thin out the stand of newly headed out rice in good years and cook the heads in a stew. It was to their advantage to hold down rice yields to not encourage the landlord to raise the standard production figure (Morrow and Sherper, 1970).

to former tenants and workers. A three hectare ceiling on land holding was established for each farm household. Excess land was distributed among tenants. Korean landlords received land securities in the beginning, and were later compensated in cash at the government's regulated rice price, which was much lower than the going market price of rice. This way, the government managed to redistribute income from the rich to the poor while at the same time overcoming own capital shortages and enhancing investment into agricultural and industrial infrastructure (Jeon and Kim, 2000). Tenancy became legally prohibited. The reform, which was implemented with the assistance of U.S. military forces, led to a sharp increase in ownership and reduction in average farm size. The percentage of tenants among all rural households decreased from 45.8 in 1949 to practically zero in 1952, only to increase slightly again afterwards (6.8% (1960), 9.7% (1970)). Average farm sizes decreased from 2.06 ha per rural household in 1950 to 0.88 ha in 1960 and 0.93 ha in 1970 (Fan and Chan-Kang, 2005). While land was fully redistributed by 1952 (Morrow and Sherper, 1970), compensation payments to landlords and tenants' payments to the government were practically finalized by the beginning of the 1960s.

As a result of the reform, 1.29 million hectare of land changed ownership. Of this total amount, 21 percent was confiscated land from Japanese landlords, 23 percent was land redistributed by the government through the ALRAA scheme, while as much as 55 percent was land targeted by the reform and freely sold in the market in anticipation of ALRAA (KAERI, 1989, pp. 1030-31).

Korea had been under Japanese colonial rule and was then occupied after the Second World War by U.S. troops who governed the country between 1945 and 1948. Several developments led to the Land Reform Law of 1950 in South Korea. First of all, the South Korean post-war government was anti-colonial and so it confiscated land from the Japanese. Second, rural landless and land-poor had already been organized in protests during colonial times. This facilitated implementation of the reform with a great deal of support and participation by the beneficiaries. Moreover, the weak government after 1945 in comparison with the preceding colonial administration led to a situation in which transaction costs for landlords to enforce tenants' payments saw a sudden sharp increase implying that tenants' rents were de facto reduced already as early as 1945.⁵ Third, especially the U.S. occupants feared that North Korea with the support of the USSR could try to mobilize the class of rural poor in the South

⁵ For the same acreage of sharecropping land, a landlord could collect 1,500 suk of rice during the colonial period. This rent reduced to 100 suk right after August 1945, and 400 to 500 suk after 1946. One suk equals approximately 180.4 liters. Note that the U.S. military administration had set official rental rates for tenancy at one third of annual crop yields in October 1945, down from on average 50 percent before.

to overthrow the Southern government. And fourth, there had always been competition between the North and the South with respect to the economic model chosen. Thus, political momentum and increased transaction costs for the rural oligarchy eventually led to large redistributions of land around the years of the official reform in 1950.

Even though redistribution of land in Korea succeeded in creating a more equal rural asset base, it failed in establishing a minimum average size of land ownership. Due to geographic restriction (most of the country consists of mountainous terrain which does not allow for agricultural production) and high population density, scarce land had to be distributed among many farmers. Thus, a high degree of fractionalization of land was the natural consequence posing a natural limit to economies of scale production. In fact, after land reform in 1953, 41.2 percent of all farm households cultivated less than half a hectare, while 33.3 percent cultivated between 0.5 and 1 hectare of own land (Pak et al., 1966; Morrow and Sherper, 1970).⁶

The Korean War (1950-53) interfered with the land reform period, particularly with the post-reform period. As mentioned above, three quarters of redistributed land had already changed owners by the time that ALRAA was enacted in March 1950, i.e. three months before the invasion of North Korean forces into South Korea. Enforcement of ALRAA was only slightly delayed (MOAF, 1966). The war led to about one million casualties among the South Korean population.⁷ However, displacement of farmers from their farms remained rather negligible since South Korea was merely occupied for about three months during 1950 before joint South Korean and U.S. forces pushed back Northern troops. Thus, the major economic impact resulting from the war is reflected in the decline of farm population due to war casualties by about ten percent and in the form of widespread destruction of industrial property and infrastructure. The latter effects led to the imposition of a land tax enacted in September 1951 in order to rebuild industrial structures. This levy on the rural population combined with forced rice sales to the government at below-market prices from February 1950 onwards is likely to lead to an underestimation of individual welfare changes after the land reform (Pak, 1966a).

This paper tries to show that the 1950 Land Reform brought about both equity and efficiency gains in the Korean economy. As Pak (1968) notices, it succeeded in changing the rural social

⁶ The 1965 Farmland Survey asked people for their preferred and present cropland sizes both including owned and rented land. Farm families with less than 1 hectare of land cultivated an average 0.56 ha and would have preferred a size of 1.2 ha. Families with more than 1 ha cultivated on average 1.6 ha and would have preferred on average 1.97 ha. It is also shown that larger households possessed on average more land but would have also preferred a much higher increase of land than smaller households (Pak, 1968).

⁷ Compare with Table 1 ahead.

framework from a feudalistic two-class society into a much more equal one with near equality of opportunities. However, it might be the case that a change from tenancy to ownership alone has only modest impacts on agricultural productivity if land turns out to be highly fragmented and complementary policies remain absent. In fact, Korean agricultural productivity saw stronger growth after 1962 when Park Chung-hee's military government issued its first Five-Year Development Plan. It focused likewise on the increase of agricultural output and the creation of heavy industry (Pak, 1966b; Morrow and Sherper, 1970). The agricultural part of the plan, which aimed at achieving Korea's food self-sufficiency through increased agricultural productivity, led to a rapid increase in the use of modern technologies and interlocked services such as increased supply of fertilizer, pesticides, improved seeds, improved irrigation, and access to credit and extension services. Japanese colonial officials had pushed modern technologies and agricultural services forward already in a first wave of agricultural reforms throughout the 1920s and early 1930s.⁸ However, the years after liberation, with the Korean War (1950-53) and weak governments, had seen technology and service provision in Korea at a low. Besides that the Five-Year Plan of 1962 issued several policies supporting small-scale farmers and the agricultural sector as a whole. Financial strain on the rural population was relaxed by a re-arrangement of terms of farm debt, provision of farm management funds, establishment of fair prices for farm products⁹, consolidation of agricultural credit institutions, improvement of commodity loans on the farm crops, as well as the establishment of a bank for small business. Moreover, unjustly-acquired properties were confiscated by the government and the government took control over the supply of commercial fertilizers (Pak, 1966b).

3. Effect of Rural Reforms on Agricultural Productivity

In order to identify the effect of the two waves of agricultural reforms on agricultural productivity and individual height outcomes this study proceeds as follows. This section

⁸ Major institutions involved in this process were (1) the Korean Agricultural Associations (KAA) which was responsible for seeds, fertilizer and farm equipment and had 15,000 employees nation-wide, (2) the Federation of Financial Associations (FFA) which was responsible for credit supply, and (3) the national and local government administrative units which laid out exact agricultural programs and watched over their implementation (Morrow and Sherper, 1970). Besides that, an Agricultural Experiment Station had been installed under the Japanese in Suwon. A 1954 UN Report concludes that the interlocking services were simple, direct and enforced.

⁹ The law of crop control from February 1950 led to a two-price system in Korea which might have been considered 'unfair' by Korean farmers. Farmers were obliged to sell between 10 and 24 percent of their output (depending on farm size) to the government at below-market prices (approximately 50 to 60 percent of the going market price).

presents the estimation of an agricultural productivity model using farm output per capita and per farm capita¹⁰ as the relevant productivity measures and including relevant controls to proxy for the rural reforms. Since agricultural production was almost completely devoted to domestic food consumption, this should be a valid proxy for Korean households' food availability around the time of the reforms. In section 4, height and agricultural productivity time series will be examined for the presence of structural breaks around the years of the reforms 1950 and 1963.

3.1 Historical Farm Data

This study uses various macro sources to access national-level farm variables from 1941 onwards. Data on total farm production, farm households, farm population, and land inequality comes from Keidel (1981), while data on farm land comes from both Cheong (1975) and Keidel (1981). Tenancy rates are taken from Bank of Chosun (1948) and KAERI (1989) as cited in Jeon and Kim (2000). The fertilizer index is constructed using annual growth rates of chemical fertilizer production from UNKRA (1954) as reported in Morrow and Sherper (1970) for the period 1941 to 1952 and of chemical fertilizer sales from Keidel (1981) for the period 1952 to 1974. Irrigation data comes from various editions of the Ministry of Agriculture, Forestry and Fishery's (MAFF) Yearbooks of Agriculture as reported in Morrow and Sherper (1970). Data on farm credit employees is also taken from Morrow and Sherper (1970). GDP and population data are from Kim (2009) and CPI data from Kim and Park (2007). Note that all values until 1945 represent only the values for the provinces that today form part of South Korea and not the North Korean part, the only exception being the share of irrigated paddy land.¹¹

3.2 Land Reform and Trends of Agricultural Input and Output

Korea's rural economy went through continuous change over the 20th century, as it developed from a traditional labor-intensive semi-feudal system at the end of the Joseon Dynasty to a

¹⁰ Farm output divided by farm population.

¹¹ While some series are complete, missing values needed to be adjusted for in some cases. Thus, six years of the farm land and three years of the tenancy rate variable were filled up using linear interpolation. For irrigation and land inequality, there is usually only one observation every five years. Here, too, linear interpolation was used to fill the gaps. Moreover, in the land inequality variable the years around the land reform were coded such that a linear decrease took place between 1947 and 1952 as observed in the qualitative literature.

post-modern, capital-intensive sector today. The main advances certainly took place during the 25 years after liberation in 1945. Table 1 shows important agricultural input and output variables from 1941 to 1974. Total farm output decreased during the first three years following liberation but then increased again from 1948 onwards, during the time when the government started the distribution of confiscated Japanese land and Korean landlords started selling their land. State-led land redistributions around 1950 entirely changed rural, social and economic composition, as can be seen by a large drop in tenancy rates and land inequality. While 58.5 percent of all farmers in 1941 were tenants, this number had dropped to practically zero around 1950. The redistribution brought down the Theil measure of land inequality from 0.925 in 1946 to 0.255 in 1955. Compared to the end of the Japanese occupation period, a strong increase in the share of irrigated paddy fields can be observed around the time of the land reform. Partly, this can be assigned to government investments resulting from surpluses generated through the ALRAA scheme. At the same time, as theory suggests higher ownership leads to increased investment in the cultivated land. Thus, between 1945 and 1955 the share of irrigated paddy rose from about 20 to almost 50 percent. After the Korean War had come to a halt in 1953, growth in agricultural inputs was rather slow throughout the 1950s, which then also translated into slow growth of the whole agricultural sector. Tenancy rates as well as land inequality were slowly on the rise again, but remaining on relatively low levels. After the Park Chung-hee administration then took power and started the first Five-Year Development Plan, the application of modern agricultural technology inputs strongly increased, as can be seen in a 75 percent increase of fertilizer sales and a 263 percent increase in pesticide sales between 1962 and 1963. Interestingly, farm output did not increase directly, yet it did in the following years by about 20 to 40 percent. The reforms were flanked by an increase in the number of crop varieties, an increase in agricultural research and development, and a broader supply of farm credit. The number of farm credit employees had risen by 150 percent between 1958 and 1965. Population figures show how the beginning of massive rural-urban migration was supported by the agricultural sector: Rising agricultural productivity was setting free rural labor for the emerging industrial sector during the 1960s. Thus, while total population was strongly increasing, farm population as well as the number of farm households reached their maximum in 1967 and declined thereafter.

[Table 1 about here]

3.3 Econometric Model

In order to assess the relative importance of individual production factors for total agricultural production, a World Bank study by Ahn, Singh and Squire (1981) can be used. The authors analyze a simultaneous consumption and production model for 443 Korean farm households surveyed in 1970. Averaged over the households surveyed, total production costs split up into 28 percent variable input costs (fertilizer, irrigation, pesticides, seeds, salt), 66 percent labor costs (family plus hired labor), 2 percent draft animals costs, and 4 percent interest charges. Thus in 1970, after modernization was launched, approximately two thirds of production costs accounted for labor and one third for variable inputs. In order to evaluate the effect of the two rural reforms on agricultural productivity, an agricultural production model of the following form will be estimated:

$$Q_t = \alpha + \beta_1 fland_t + \beta_2 fpop_t + \beta_3 fert_t + \beta_4 irrig_t + \beta_5 landinequ_t + \beta_6 kwar_t + \varepsilon_t \quad (1)$$

Q_t denotes agricultural production per capita or per farm capita in year t , $fland_t$ and $fpop_t$ denote total farm land and total farm population in t . The variables $fert_t$ and $irrig_t$ represent an index of fertilizer use and the share of irrigated paddy land, respectively, where the former will be the main proxy for intensification reforms in 1963. Increased use of commercial fertilizers has been identified as the most important factor in the reforms after 1962/63 in many studies (see e.g. Pak et al., 1966, p. 106).¹² The land reform in 1950 enters the model through the variable $landinequ_t$, which will be measured in two alternative ways: (1) decreased land inequality as measured by a Theil index for land, and (2) increased land ownership as measured by the tenancy rate.¹³ The variable $irrig_t$ controls for the share of irrigated paddy land, while $kwar_t$ controls for particular effects of the Korean War.¹⁴

It can be safely argued that the rural reform variables are exogenous. Land redistribution had mainly political reasons strongly related to weak governments that were unable to sustain the old social and political order after the departure of the Japanese (Jeon and Kim, 2000). At the same time, land redistributions in the North put further pressure on the U.S. military government in the South since they faced Communist tendencies among Southern farmers.

¹² Morrow and Sherper (1970) argue that the breakdown of the KAA and limited resources of the FFA led to a general slack in the supply of farm inputs after liberation which then only recovered following the reforms in the early 1960s.

¹³ Since the tenancy rate time series is more complete, and the Theil land inequality measure requires substantial interpolation, the annual variation of the tenancy measure is likely to be more reliable.

¹⁴ For effects of war on heights see also Moradi (2005).

Agricultural technology reforms in the 1960s were then designed by the Park Chung-hee administration in order to lay the foundation for future industrial growth allowing industrial sectors to absorb agricultural surplus labor. Therefore, it is plausible to assume one-way causality in both cases.

In order to estimate equation (1) time series properties of all series have to be taken into account. Standard unit root tests (ADF, Phillips-Perron) indicate that all agricultural series in the model are integrated of order one. Thus, taking first differences and adding lagged values on the right hand side of the model allows the use of least squares estimation to consistently estimate an autoregressive distributed lag model (Greene, 2003) of the form:

$$d(Q)_t = \sum_{i=1}^k \gamma_i d(Q)_{t-i} + \sum_{j=0}^l X'_{t-l} \beta_{t-l} + \varepsilon_t \quad (2)$$

where X_t is a vector containing all explanatory variables from equation (1). Estimation of a very general model with $i = 3$ and $j = 3$ strongly decreases the number of degrees of freedom in the estimation. Thus, I apply Hendry's general-to-specific method and stepwise exclude right-hand side variables which show the lowest t-values. The results can be seen in Table 2. The dependent variable enters the final model with two lags. Farm population, farm land, fertility index, and the share of irrigated paddy only have a contemporaneous effect on agricultural output, which is in line with the theory. Land inequality and tenancy rate however, do not have a direct effect on agricultural output, but one that is lagged three periods. Adaptation to ownership, initial uncertainty about land rights in the war period and thus resulting reduced investment and cultivation effort might be possible explanations.

[Table 2 about here]

Columns (1) and (2) of Table 2 show the determinants of agricultural production per farm capita (farm output divided by farm population), while columns (3) and (4) show the models with agricultural production per capita (farm output divided by total population). Negative significant coefficients for the lagged dependent variables indicate a tendency towards mean reversion of the series. Farm land and share of irrigated paddy are positively linked with agricultural productivity, while the Korean War decreased farm output. The 1950 Land Reform seems to have increased agricultural productivity with a three years time lag: Both land inequality and tenancy rate show negative significant coefficients in all regressions. Moreover, results also suggest a positive effect of the 1962/63 reforms: The fertility index is positive and significant in all specifications. For all regressions, respective LM-tests indicate no presence of serial correlation in the residuals.

4. Effect of Rural Reforms on Individual Well-being

4.1 Body Height and Individual Welfare

The method of the biological standard of living (BSoL) uses individual height data as a proxy for individual welfare during historical periods for which no household income or consumption data is available. The strong relationship between early childhood household economic conditions and heights has been frequently documented (Komlos, 1993; Komlos and Baten, 1998; Steckel, 1995; 2009; Hoddinot et al., 2008; Deaton, 2008). Final height outcomes are correlated with nutritional intake during the first three years of a person's life, and here particularly during the first 12 months after birth.¹⁵ Nutritional conditions in turn highly depend on relative food prices and a household's income situation. In the case of agricultural self-production, ownership of productive assets is crucial. Thus, welfare trends of a large enough sample of a particular population can be inferred from height data. In the context of the rural economy, Kopczynski (2007) uses height data and finds stagnating mean heights for the birth cohorts 1882-1892 in the Kingdom of Poland resulting from an agrarian crisis, whereas those born in the adjacent province of Galicia, which carried out far-reaching agrarian reforms and closed the border for trade instead, continued to grow in mean height.

When working with height data it is important to deal appropriately with the issue of shrinking of old-age cohorts. While individuals usually reach their final height around the age of 20 to 30, shrinking usually starts from the age of 40 to 50 and then accelerates in later periods of life. Cline et al. (1989) as well as Chandler and Bock (1991) provide gender-specific formulas to adjust for shrinking. These formulas have been applied in the East Asian context by, among others, Pak et al. (2010) on Korean data, and Morgan (2008) on Chinese data. Both adjustment methods will be applied in the following.¹⁶ Using height data, the problem of "age-heaping" might bias estimates, in particular, when less educated individuals misreport their exact age and thus tend to report rounded years. This would then lead to biased sample mean height trends in the data. However, this does not present a problem for the Korean data used here. Due to initially high literacy already in the first half of the 20th century

¹⁵ Of special importance is the availability of proteins. To a lesser degree, also vitamins A, D, as well as minerals play a role for height (Silventoinen, 2003).

¹⁶ While Chandler and Bock's method only controls for old-age shrinking and thus should only be applied to those aged 40 and above, adjustment according to Cline et al. additionally corrects for not fully reached final height of the young age cohorts.

as well as the cultural importance of the 12-year animal cycle of the Chinese zodiac, birth years are generally well known and thus age-heaping is not seen in the data set.¹⁷

Korea in the 20th century has gone through one of the fastest anthropometric growth spurts ever seen in human history. While the second half of the century has certainly been more successful than the first half, even under Japanese colonial rule Korean average heights show a positive trend. Choi and Schwekendiek (2009), pooling various height series, estimate an increase of approximately two centimeters in average male adult heights during the colonial period from 1910 to 1945. While representing one of the darkest chapters in Korean history, the occupation period brought Korea important advances in education, health, and other basic infrastructure. The Japanese moreover modernized agricultural technologies in a first reform period during the 1920s and early 1930s. However, a gradual increase in forced rice collections from Korean farmers to sustain Japanese wars in the Pacific, beginning with the Japanese invasion of Manchuria in 1931 and lasting until the end of World War II in 1945, led to a worsening of the nutritional situation in the later colonial years.¹⁸

Individual height data used in this paper comes from Korea's National Health and Nutrition Surveys (KNHS) which have been collected regularly by the Korean Institute of Health and Social Affairs since 1995. Four nationally representative cross-sections collected in 1998, 2001, 2005 and 2007/08 have been published. For the purpose of this paper, the data offers basic demographic and anthropometric information for between 3,051 and 5,333 randomly selected households per cross-section. KNHS data reports measured heights at the first decimal. Excluding ages below 20 and extreme heights below 120 cm and above 200 cm, the final data set comprises 16,580 females and 12,705 males, respectively. The number of observations per five-year birth cohort can be seen in Table 3.

[Table 3 about here]

Figure 1 shows the trend in average height of Korean female and male adults from 1920 to 1987. Depending on the method of shrinking-adjustment, the trend lines show that average female heights increased over this 67-year time span by between 8.1 and 12 cm. Average male heights grew a little slower, but still by a strong 7 to 9.6 cm. This stronger female growth might reflect decreasing gender inequality in education and consumption which took place over the 20th century. It is remarkable that for both men and women about two thirds of

¹⁷ Besides that, Korea has a long history of detailed administrative record keeping. Regressing heights on age-heaping dummies shows no problems with age-heaping in the data.

¹⁸ For further evidence on development of average heights during the first half of the 20th century see e.g. Kimura (1993).

this growth took place after the land reform in 1950, and even about 40 to 50 percent of the growth took place after 1962. Data quality might be compromised by survivor bias which has been found in past studies (Waalder, 1984; Steckel, 1995). According to these studies, there is a bias in older age cohorts in that taller people are on average more likely to survive a certain age than shorter people. Thus, estimating the mean of elder birth cohorts might lead to an upward bias in the estimated mean. This would then lead to an underestimation of growth over the whole period. However, as the bias would decrease in a *gradual* manner when moving to younger cohorts, this should not pose a problem for the following structural breaks analysis. The survivor bias is rather unlikely to produce abrupt breaks in the height series.¹⁹

[Figure 1 about here]

4.2 Testing for Structural Breaks in Time Series

Human body growth theory suggests that a person's final height outcome depends on both genetic and environmental factors. While the parents' heights play the major role in determining final height outcomes in the developed world, in nutrition and health constrained developing countries, environmental factors are still of high relative importance. The foremost environmental factor is a child's postnatal nutritional situation and thus this will be the basis of this study's main line of argument. In Korea, food expenditures accounted for a very high share in total farm household expenditures during the time of this study. While the Engel coefficient, the share of total household expenditures spent on food, was as high as 73.6 percent in 1954, by 1964 it had slightly reduced but still stood at 59.3 percent (Pak et al., 1966). Second in rank is the postnatal disease environment of the newborn.²⁰ Geographic and climatic conditions play further roles in explaining final height outcomes but are more important in the analysis of large countries or cross-country height comparisons (Silventoinen, 2003; Komlos, 1993; Komlos and Baten, 1998).

¹⁹ One might argue that the survivor bias might produce breaks in height series in the case of the Korean War if soldiers were more likely to be recruited among poorer parts of the population. However, this should then lead to a bias around the age cohorts 1930 to 1935, a period that is excluded from the following time series analysis.

²⁰ Data on health indicators would also be interesting to study. However, there is a serious lack of data on health indicators between 1942 and 1955 for Korea. Since nutrition is a strong determinant of health, these two are likely to be highly correlated.

In order to identify potential effects of the two rural reforms in 1950 and 1963 on average individual welfare, I will examine the height time series of women and men for the existence of potential structural breaks around the years of the reforms. Following the theory of the Biological Standard of Living and assuming nutritional improvements through the rural reforms, one should expect increases in intercepts or trends of final height outcomes of those born after the reforms.

Running standard unit root tests (ADF, Phillips-Perron) for the height series without allowing for structural breaks results in no-rejection of a unit root. However, as Perron (1989) points out, the power to reject the null of a unit root decreases if the stationarity alternative is true, but structural breaks are ignored. Thus, he suggests a modification of the ADF test allowing for a known structural break. The break can be in the intercept, in the trend, or in both. Zivot and Andrews (1992) argue that break points (BP) might not be exogenous in some cases and thus selecting exogenous break points when the data is already known could lead to an over-rejection of the null hypothesis of a unit root. In the case of the Korean rural reforms, structural breaks could be determined exogenously as has been argued earlier. However, in order to check for validity of these breaks, first successive Zivot-Andrews (ZA)-tests are run in order to account for two endogenous breaks in the series. The ZA-model specification with shift only in trend for time series y_t can be written as follows:

$$y_t = \mu^A + \alpha^A y_{t-1} + \beta^A t + \gamma^A DT_t + \sum_{l=1}^m \delta_l^A \Delta y_{t-j} + \varepsilon_t \quad (3)$$

The ZA-model with both shift in intercept and slope is then:

$$y_t = \mu^B + \alpha^B y_{t-1} + \beta^B t + \theta^B DC_t + \gamma^B DT_t + \sum_{l=1}^m \delta_l^B \Delta y_{t-j} + \varepsilon_t \quad (4)$$

Here, DT indicates an additional trend and DC a shift in the intercept such that

$$DT_t = \begin{cases} t - BP & \text{if } t > BP \\ 0 & \text{otherwise} \end{cases} \quad (5)$$

and

$$DC_t = \begin{cases} 1 & \text{if } t > BP \\ 0 & \text{otherwise} \end{cases} \quad (6)$$

The model with only a change in the intercept can be omitted since this does not seem to be relevant for the shape of this study's time series. The models in equation (3) and (4) on the series of heights for women and men are run separately for the two methods of shrinking-adjustments. Moreover, they are also run for agricultural productivity. Being interested in determining two break points, I estimate two successive ZA-tests on the series. The first test is estimated over the whole series. After obtaining the first break point BPI , I then run the

second test over the series $[t_1 \text{ to } (BP1 - 1)]$ if $|t_1 - BP1| > |BP1 - t_T|$ or over $[(BP1 + 1) \text{ to } t_T]$ if $|t_1 - BP1| < |BP1 - t_T|$.

[Table 4 about here]

Table 4 shows the results of the endogenous detection of the break points. Columns (1) and (2) show results from the estimation of equation (3) for a mere shift in trend. While the first break in trends is found to have taken place between 1948 and 1957, the second break seems to have taken place between 1961 and 1965. This does support the existence of break points around the rural reforms. Columns (3) and (4) result from estimating equation (4) for shifts both in intercept and in trend. Here, the first significant change in male heights and farm productivity happened between 1951 and 1954, while the model fails to detect a significant break of female heights during that period. The second break is detected between 1964 and 1971. Thus, except for the last column, results from this exercise support the hypothesis of structural breaks around 1950 and 1963.

In a further step, the structural break points are assumed to be known and to be located in 1950 and 1963. Thus a model of the following form is estimated:

$$y_t = c_0 + \beta_1 DC_{add50,t} + \beta_2 DC_{add63,t} + \beta_3 T_0 + \beta_4 DT_{add50,t} + \beta_5 DT_{add63,t} + \varepsilon_t \quad (7)$$

where $\varepsilon_t = \varphi \varepsilon_{t-1} + \eta_t$ follows an AR(1) process with idiosyncratic error term η_t . In (7) c_0 and T_0 represent the general intercept and general linear trend, while DC_{add50} and DC_{add63} are shifts in intercept and DT_{add50} and DT_{add63} are shifts in trend which are defined as in equation (5). Equation (7) can be estimated for height and agricultural productivity series using least squares. Results are displayed in Table 5.

[Table 5 about here]

From column (1) it can be seen that farm output per capita experienced a structural change in 1950. Before 1950, agricultural productivity stagnated. Then in 1950, short-run dynamics probably related to the outbreak of the Korean War decreased agricultural productivity as can be seen in the significant downward move of the intercept. Yet, agricultural per-capita output entered a stable long-run growth after 1950. Looking at farm output per farm capita one can observe short-run decreases both in 1950 and 1963, yet only the latter turns out significant. The trend behavior indicates that productivity experienced an acceleration of growth rates

both in 1950 and 1963. This confirms the findings in Table 2 that both rural reforms had positive long-run impacts on agricultural productivity.

Is there evidence for an improvement of the nutritional situation in the Korean population? Columns (3) to (6) try to answer this question. Here, shifts in intercept were left out since they turned out to be insignificant in all models. Female heights grew at a steady absolute rate already between 1941 and 1949 (0.16 cm Cline-adjusted (.09 cm CB-adjusted)). This growth rate then continued after 1950 and eventually experienced an upward shift to 0.28 (0.24) cm annual growth from 1963 onwards. Male heights did not grow in the pre-1950 period, yet reached an average annual growth of 0.16 cm from 1950 to 1962 which then further increased to an annual 0.21 (0.24) cm between 1963 and 1974. Thus while male heights show a structural break in form of an upward shift in trend both in 1950 and 1963, there is only one break point for women in 1963.

[Figure 2 about here]

Figure 2 graphically displays the results of columns (1) to (4) of Table 5.²¹ Actual series as well as fitted trend lines containing structural breaks in 1950 and 1963 are shown. Note that in the figure I exclude the AR-dynamic of the residuals included in the econometric model to illustrate more clearly break points and deviations of the time series from the estimated trend. Strong, negative effects of the Korean War can easily be observed in almost all four series. Besides, an upward trend that is increasing over time can be seen.

5. Concluding Remarks

The Korean Land Reform in 1950 is often cited as an example for successful land reform (e.g. Ray, 1998). From an equity point of view massive land redistribution resulted in tremendous democratization of rural areas providing a more equal distribution of productive assets, income and political power within the Korean population. The resulting long-run effects for growth and development cannot be overstated. It is remarkable, that even with a high fragmentation of land after the reform, increased ownership still led to significant efficiency and productivity gains as found in this paper. In a rural generation which suffered from war, a large influx of migration from urban areas, as well as bad governance until the early 1960s, increased ownership of land secured nutrition and stabilized individual welfare.

²¹ Results in columns (5) and (6) are very similar to those in (3) and (4) and are thus not displayed graphically.

Without doubt, land reform effects could have been even stronger in 1950 if directly combined with rural technology and infrastructure reforms in the first place. However, Korean farmers had to wait more than a decade until in 1962/63 Green-Revolution type reforms were implemented by the Park Chung-hee administration leading to strong agricultural productivity growth in the following.

Individual welfare measured with the help of anthropometric data shows strong growth over the 20th century in Korea. Between the birth cohorts of 1920 to 1987 average adult heights grew by 8.1 to 12 cm for women and by 7 to 9.6 cm for men, respectively. Two thirds of this growth took place after the land reform in 1950, and about 40 to 50 percent after the 1962/63 reforms. Structural break analyses of height trends reveal significant upward shifts in trend around the years of the reforms. Effects of the 1950 reform might even be underestimated due to the costs of the Korean War which were widely paid for by the farm population in form of additional 'reconstruction taxes' during the 1950s.

Korean rural reforms thus not only increased equity but also efficiency of the rural economy and the economy as a whole. The Korean case might hold important lessons for agricultural-based economies still marked with high rural asset inequality and low productivity in less developed economies in Africa, Latin America and Asia. The design of rural reforms in a holistic way that combines both land redistribution and productivity enhancing policies should be given particular importance.

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Figures and Tables

Table 1: Agricultural input and output summary statistics

Year	Total farm output	Farm population	Farm households	Total population	Farm land	Irrigated paddy	Fertilizer sales (chem.)	Pesticide sales	Farm credit employees	Tenancy rate	Land inequality
	(billions 1970 Won)	(million)	(million)	(million)	(million ha)	(share of total)	(Index: 1952=100)	(100,000 met. tons)			(Theil measure)
1941	340	12.2	2.13	15.6	2.14		154.5			.585	
1942	285	12.2	2.12	15.9	2.13		125.9		6,226	.588	
1943	341	13.3	2.31	16.1			111.4			.546	
1944	367	12.9	2.24	16.3			93.0		6,638	.524	
1945	306	11.4	2.02	16.6		.206	68.8			.502	.854
1946	316	12.6	2.1	18.4			68.7		4,709	.463	.925
1947	341	13.7	2.17	19.2			68.4			.425	
1948	398	14.1	2.32	19.8			153.6		4,110		
1949	411	14.4	2.47	20.2	2.07		181.4			.458	
1950	364	12.9	2.26	20.4	1.97	.466	286.6				
1951	264	12.9	2.25	19.8	1.96		22.6				
1952	306	12.9	2.23	20.2	1.96		100	6.8		0 ¹	.200 ¹
1953	394	13.1	2.25	20.2	1.95		102	7.8			
1954	431	13.2	2.23	20.8	1.97		113	16.8			
1955	445	13.3	2.22	21.4	2.01	.494	124	40.2		.052	.225
1956	398	13.4	2.2	22.0	2.00		133	48.2		.055	
1957	442	13.6	2.21	22.7	2.01		142	67.6		.058	
1958	473	13.7	2.22	23.3	2.02		144	51.1	4,320	.061	
1959	479	14.1	2.23	24.0	2.03		142	55.7		.065	
1960	465	14.6	2.35	25.0	2.04	.55	141	58.8		.068	.248
1961	544	14.5	2.33	25.8	2.05		178	55.7		.064	
1962	529	15.1	2.47	26.5	2.08		198	51.8	7,519	.06	
1963	508	15.3	2.41	27.3	2.08		347	188		.056	
1964	617	15.6	2.45	28.0	2.18		372	234		.052	
1965	607	15.8	2.51	28.7	2.26	.574	393	127	10,810	.07	.243
1966	699	15.8	2.54	29.4	2.30		423	126		.075	
1967	662	16.1	2.59	30.1	2.32		486	100		.081	
1968	679	15.9	2.58	30.8	2.32		478	100		.086	
1969	746	15.6	2.55	31.5	2.31	.762	535	175	9,451	.092	
1970	723	15.2	2.51	32.2	2.29		563	250		.097	.267
1971	752	14.7	2.48	32.9	2.27		605	300		.089	
1972	760	14.7	2.45	33.5	2.25		648	332		.081	
1973	786	14.6	2.45	34.1	2.24		793	364		.073	
1974	819	13.5	2.38	34.7	2.25		837	626		.077	

For various sources see Data section in 3.3. ¹=assumed minimum values for tenancy rate and land inequality at the end of land redistribution in February 1952.

Table 2: Determinants of Agricultural Output (1944-1974)

	d(Ypfarmc)	d(Ypfarmc)	d(Ypc)	d(Ypc)
	(1)	(2)	(3)	(4)
Dep. Var. (-1)	-.576*** (.135)	-.670*** (.141)	-.333** (.158)	-.510*** (.158)
Dep. Var. (-2)	-.494*** (.122)	-.503*** (.120)	-.471*** (.138)	-.563*** (.129)
d(Farm population)	-3.623*** (.796)	-3.782*** (.791)	-.663 (.617)	-1.028 (.577)
d(Farm land)	34.02** (13.87)	47.42*** (13.24)	11.76 (10.16)	18.55** (8.86)
d(Fertility index)	.018*** (.006)	.013** (.007)	.010** (.004)	.008* (.004)
d(Share of irrigated paddy)	68.06*** (16.50)	57.93*** (15.96)	4.058 (10.92)	-2.074 (9.85)
d(Land inequality, Theil) (-3)	-31.54*** (8.30)		-14.48** (6.00)	
d(Tenancy rate) (-3)		-33.55*** (8.49)		-20.81*** (5.93)
Korean war	-7.162*** (1.85)	-3.91** (1.47)	-3.583** (1.38)	-2.484** (1.03)
N	31	31	31	31
Adj. R-squared	.624	.636	.424	.530
F-statistic	8.13	8.49	4.15	5.83

Notes: Standards errors in parentheses. *** significant at 1%, ** significant at 5%, * significant at 10%.

LM tests indicate no serial correlation in residuals. For various sources of national-level farm data see data section 3.3.

Table 3: Observations per birth cohort (of variable height)

	No. of females	No. of males
1920-1924	301	177
1925-1929	594	320
1930-1934	888	624
1935-1939	1209	946
1940-1944	1297	1014
1945-1949	1269	1053
1950-1954	1335	1116
1955-1959	1820	1515
1960-1964	1895	1564
1965-1969	1964	1473
1970-1974	1851	1407
1975-1979	1290	891
1980-1984	674	480
1985-1987	193	125
Total	16580	12705

Data: National Korean Health Surveys (KNHS) 1998, 2001, 2005, 2007/08.

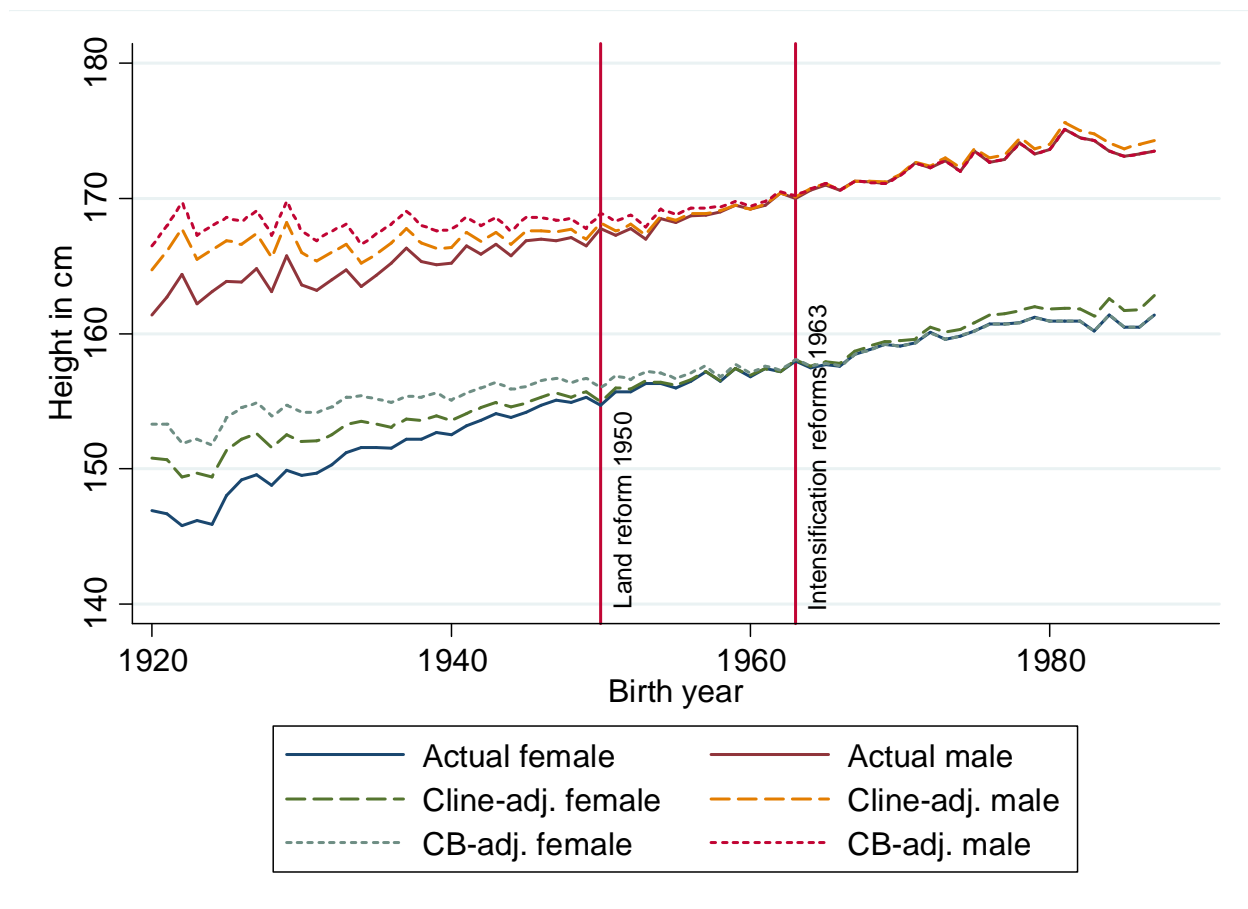


Fig. 1: Korean female and male heights, 1920-1987. Data: National Korean Health Surveys 1998, 2001, 2005, 2007/08. Age-adjustments based on Cline et al. (1989) and Chandler and Bock (1991).

Table 4: Endogenous detection of structural breaks (successive Zivot-Andrews tests)

	1st break(trend)	Significance	2nd break(trend)	Significance	1st break(both)	Significance	2nd break(both)	Significance
	(1)		(2)		(3)		(4)	
Farm output, per capita	1952	***	1961	***	1954	***	1964	***
Farm output, per farm capita	1952	**	1968		1951	*	1966	
Height female (Cline)	1948	***	1965	**	1961		1968	*
Height female (CB)	1948	***	1965	**	1958		1968	**
Height male (Cline)	1956	***	1962	***	1953	***	1971	***
Height male (CB)	1957	***	1962	***	1953	**	1971	***

Notes: Height data from National Korean Health Surveys 1998, 2001, 2005; adjustment based on Cline et al. (1989) and Chandler and Bock (1991). Farm data from Keidel (1981).

*** significant at 1%, ** significant at 5%, * significant at 10%.

Table 5: Regression estimations with exogenous structural breaks in 1950 and 1963, data for 1941-1974

	Farm output p.c.	Farm output p.farm.c.	Height female (Cline)	Height male (Cline)	Height female (CB)	Height male (CB)
	(1)	(2)	(3)	(4)	(5)	(6)
C0	22.871*** (3.49)	22.994*** (5.92)	152.418*** (.58)	166.784*** (.47)	154.769*** (.51)	168.573*** (.49)
DCadd50	-2.620* (1.42)	-3.072 (2.32)				
DCadd63	-.403 (1.70)	-3.985** (1.93)				
T0	-.198 (.22)	.222 (.39)	.159*** (.03)	.032 (.03)	.092*** (.03)	-.018 (.03)
DTadd50	.559** (.26)	.734* (.41)	-.022 (.04)	.163*** (.03)	-.027 (.04)	.160*** (.04)
DTadd63	-.098 (.32)	1.073*** (.23)	.123*** (.02)	.051** (.02)	.147*** (.03)	.076*** (.03)
AR(1)	.111 (.17)	-.056 (.16)	-.266 (.30)	-.449* (.25)	-.273 (.30)	-.427* (.25)
N	34	34	34	34	34	34
Wald Chi-squared	22.95	509.86	1694.24	2527.05	1642.12	1642.12

Notes: Standard errors in parentheses. *** significant at 1%, ** significant at 5%, * significant at 10%. Constants in height models insignificant and thus left out.

Height data comes from National Korean Health Surveys 1998, 2001, 2005; adjustment based on Cline et al. (1989) and Chandler and Bock (1991). Farm data from Keidel (1981).

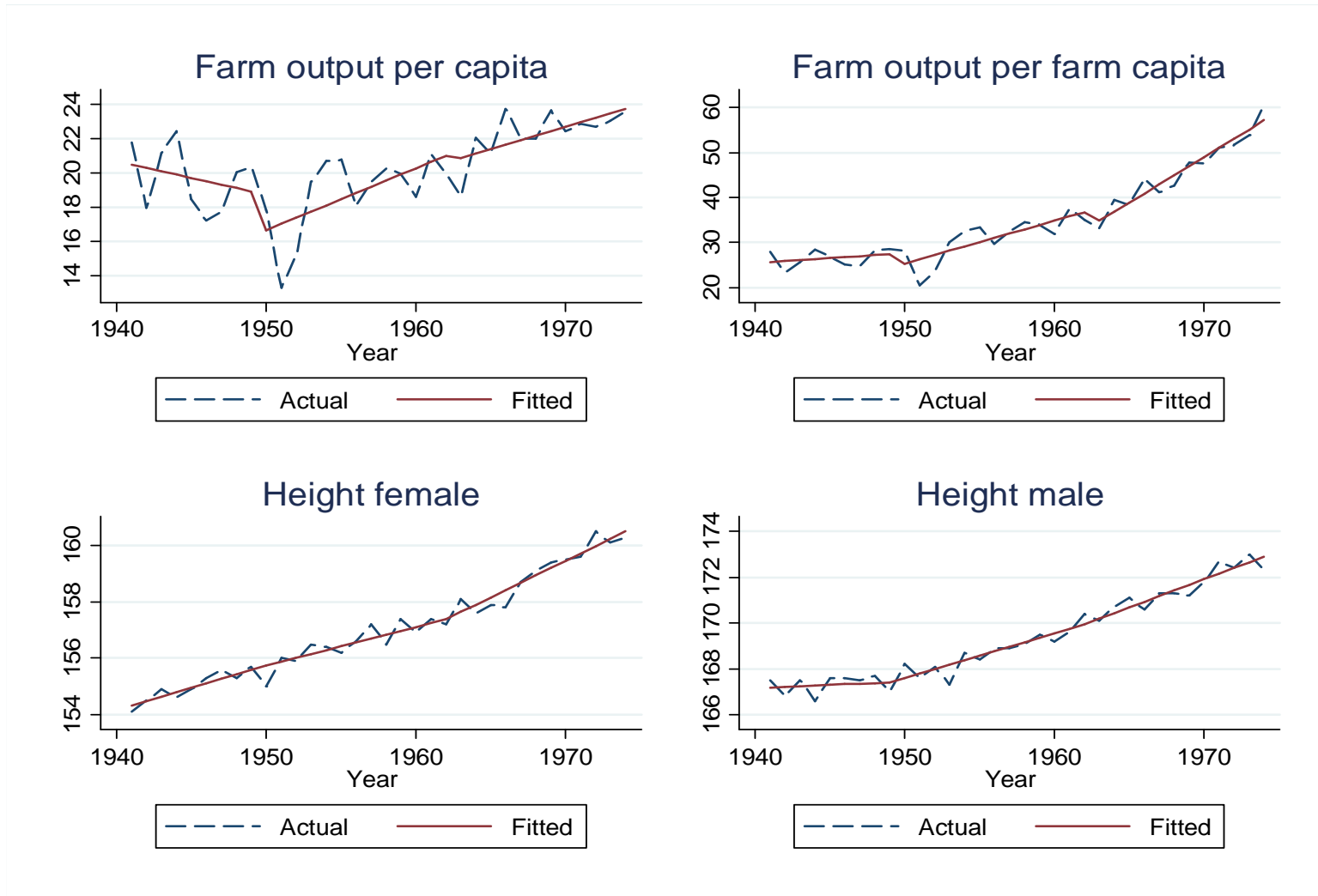


Fig. 2: Estimation of trends in farm output and heights with structural breaks in 1950 and 1963, data for 1941-1974. Height data from National Korean Health Surveys 1998, 2001, 2005, 2007/08. Adjustments based on Cline et al. (1989). Farm data from Keidel (1981).