Transition on the Han: The Agricultural Roots of Development on the Korean Peninsula

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Abstract

One of the crucial preconditions for growth in the East Asian Economic Miracle were high levels of human capital, yet an explanation for their origin has not been forthcoming in the economic literature. This project investigates the origin of these high levels of human capital in South Korea through the frameworks of induced development and labor-intensive growth. By examining both long-term processes and the effect of policies during the Japanese colonial period (1910-1945) in the Korean countryside, it's argued that labor-intensive modes of production, particularly in the case of rice cultivation, induced changes in economic preferences and behaviors. These shifts encouraged household investment in education. A working definition of labor-intensive growth is constructed and employed with data from Japanese archival, census, and survey documents for a cross-sectional regression analysis. Though in many cases labor intensity was shown to have a correlation with education, the effects were strongly differentiated by sex and by region. Further research should focus on different ways labor-intensive growth affects male and female workers.

Keywords: Korea, Education, Colonial, Labor Intensive

JEL Classifications:

N35 Economic History: Labor and Consumers • Demography • Education

Q15 Agricultural and Natural Resources: Land Ownership and Tenure • Land Use • Agriculture

Contents

1 Introduction

With the rise of the Asian tiger economies in the 1960's in East and Southeast Asia and their subsequent expansion, the idea of a unified Asian model of development as an alternative to the dominant Washington consensus held high hopes. Much of the discussion of the model focused on the fact that in many of the 'miracle growth' countries, the public sector had extensively intervened in the market for a number of goals including targeting high-growth industries, encouraging exports, and ensuring a high level of equity[1]. Critics however have questioned the effectiveness of these interventions, arguing that the so-called 'development state' either pushed along economic processes that were already on-going or that unique institutional factors prevent it from being successfully replicated. In an attempt to ground the development state in historical processes, Kohli (1994) argued for the latter and presented evidence that the origin behind South Korea's efficient public sector was a strong state-society tie created by the Japanese colonial state (1910-1945)[2]. Subsequently Duol Kim & Ki-Joo Park (2008) argued for the former, pointing to the independent rise of industrial activity during the period of Japanese rule[3]. Similar historical investigations of Japan, China, Taiwan, and Southeast Asia also show peculiar institutions and antecedents of growth of the post-war development state[4].

Defining the development state has proved a challenge. The simplest definition, a state that allows for rapid economic growth, is inadequate because it fails to integrate institutional and historical contexts. Defining the development state based on outcomes robs the term of any analytic framework. Looking within the historical and institutional contexts there are several similar characteristics between countries commonly associated as development states that should be emphasized. Evans (1995), in addressing the

[1] See MacDonald, Lawrence, ed.,"*The East Asian Miracle: Economic Growth and Public Policy, Main Report (English)*", A World Bank Policy Research Report, New York, New York: Oxford University Press (1993), pg. 1-402.

[2] Kohli, Atul, "*Where Do High Growth Political Economies Come From? The Japanese Lineage of Korea's 'Developmental State'*, World Development, 22(9), (1994): 1269-293.

[3] Kim, Duol, and Ki-Joo Park, "*Colonialism and Industrialization: Factory Labor Productivity of Colonial Korea, 1913-37*", Australian Economic History Review, 48(1), (2008): 26-46.

[4] See Chalmers (1982) for Japan, Elvin (1972), Pomeranz (2000), and Landes (2006) for China

differences between development and predatory states, connected the "structural characteristics of states" to their development outcomes. He argued that "embedded autonomy", that is when bureaucrats are both committed to a cohesive set of goals (allowing for autonomy) and are subject to complex social ties allowing for decentralized social processes to exert their presence, is a fundamental component of a development state[5]. That doesn't mean that the state must be an activist one: the set of bureaucratic goals may be to limit regulation, as is at times the mandate given to US agencies. It does however provide for an expanded role for bureaucrats than previously envisioned. As such many countries who have attempted to copy the formula to get on the development train overemphasize this expanded role by having a bureaucracy too autonomous without compensated embeddedness to act as a check. Suharto's Indonesia and Marcos' Philippines were prime examples of states where bureaucratic governments that tried to replicate the successes of the development states were captured by an inner circles of elites. The results, less than satisfying the precision of interventions of development states, often backfired and stalled growth for decades.

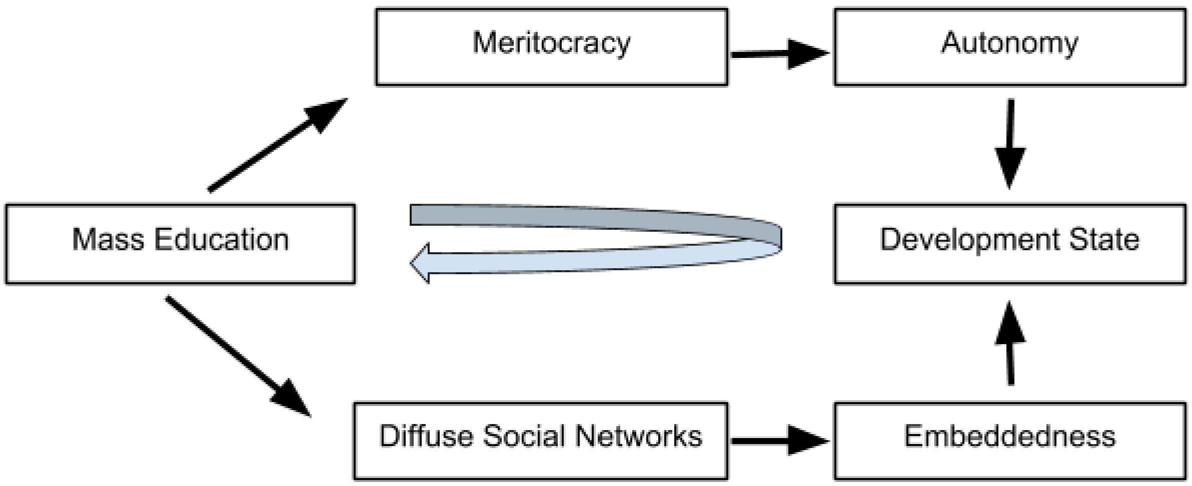
Engerman & Sokoloff (2002)[6] argued that governments which form under initial conditions of inequality will result in the capture of the state by elites who will attempt to constrict political, economic, and educational equity to engage in rent-seeking behavior. This will prevent the economy from engaging in development because of a lack of mass participation in economic growth as the economy will be strongly segmented by social groups. However, if equity can be encouraged in these fields then society and market will be less segmented. This will also mean that all groups in society will be better embedded in it. Consider that when education is restricted to a small group, that group will share strong networks within itself and few with other sections of society. The bureaucracy will almost have no choice but to consist of these members. Yet when education is widespread, not only can the bureaucracy be recruited from different segments of society, but tighter networks allow for decentralized social changes to have greater

[5]Evans, Peter B. *Embedded Autonomy: States and Industrial Transformation*. Princeton (N.J.): Princeton University Press, 1995 (pg 12).

[6]Engerman, Stanley L. and Kenneth L. Sokoloff, "*Factor Endowments, Inequality, and Paths of Development Among New World Economics*, National Bureau of Economic Research, Working Paper Series, 9259, (Oct. 2002), pg 1-43.

impact on public policy. Surveying the group of Asian development states, Rodrik (1994) remarked that "[a]round 90 percent or more of the growth of Korea, Taiwan, Malaysia, and Thailand can be 'accounted' for by these countries' exceptionally high levels of primary school enrollment and equality around 1960[7]."

Figure I: The Development State



Hence, education and equity are vital requirements of a successful developmental state. They allow for both a counterbalance to a closed elite and for broad participation in the modern economy. Education in particular seems to be vital in this case where governments that target high growth industries engaged in technologically complex production, such as cars and computer chips, require workers to be engineers in the production process. Yet as much as Asian development seems synonymous with investment in human capital, this wasn't always the case. Asia has for most of history largely lagged behind Western Europe and its offshoots in literacy. In Meiji era Japan (1868-1912), surveys in five prefectures noted that the ability to sign one's name varied from 64% in Shiga prefecture in central Japan, to as low as 18% in the southern Kagoshima prefecture. Only 6.8% could read common public notices and certificates[8]. When discussing mid-19th century Qing China, which was one of "[f]ew societies [to] have ever put more emphasis on the value of education in its various forms", Westad (2012) recorded that between 1/3-1/2 of men and up to

[7]Rodrik, Dani, "King Kong Meets Godzilla: The World Bank and The East Asian Miracle", *CEPR Discussion Papers*, no. 944 (1994): 1-42.

[8]Yakuwa, Tomohiro, "*Literacy in Tokugawa Japan*, Japanese Journal of Educational Research, Japanese Educational Research Association 70:4 (2003). pg. 524-535.

1/10 of women were literate. That's, at most, 30% of the population[9]. A 1939 census in Thailand revealed that as much as 68.8% of the population was illiterate[10]. Conditions in South Korea were even worse. One statistic claims that only 22% of residents of South Korea were literate as late as 1945[11]. That's not for understanding thousands of complex characters. That's for recognizing Hangul, which has one of the world's easiest to learn writing systems. Meanwhile, literacy in the entirety of Britain and Sweden in the late 19th century was approaching 80%. France was gaining on 70% and the Netherlands had reached modernity with 90% literacy[12]. Then, something moved, the gears shifted, and convergence occurred. Japan led the literacy charge and by the end of World War II the percentage of those who couldn't read or write kanji fell to just 2.1%[13]. In post-war China, literacy rose from a measly 20% in 1950 to 66% by 1982[14]. South Korea was perhaps the most impressive (reliable data on the North is scant). From 22% in 1945, the country's literacy rate grew astronomically, reaching 71% in 1960 and 88% by 1970[15].

Though Rodrik argued that education, specifically primary school enrollment rates, explained high growth, education enrollment itself cannot account for any of it. The skills and knowledge one gains in education, such as literacy, are the actual drivers of growth. Those countries that Rodrik noted had a high primary school enrollment rate were able to achieve their substantial rise in literacy rates in the post-war directly through enrollment in schools where children were taught basic literacy skills. That is not to say that all gains in literacy are achieved solely through the establishment of new schools. The rise of literacy in Europe between the 16th-19th centuries was largely achieved without centralized schooling. Instead, much of it was driven by religious societies and fueled by the spread of the printing press. However,

[9]Westad, Odd Arne. Restless empire: China and the world since 1750. New York: Basic Books, 2015.

[10]UNESCO. World Illiteracy at Mid-Century: A Statistical Study. Vol. 11. 11 vols. Monographs on Fundamental Education . UNESCO, 1957.

[11]Chang, Ha-Joon. Bad samaritans: the myth of free trade and the secret history of capitalism. New York, NY: Bloomsbury Press, 2009.

[12]Buringh & Van Zanden (2009), Van Zandel et al (2014), OxLAD, Broadberry & O'Rourke (2010).

[13]Yakuwa, 2003

[14]Ross, Heidi, "*China Country Study*", UNESCO Background Paper for the Education for All Global Monitoring Report: Literacy for Life, (2005), pg. 1-116

[15]Mason, Edward S. et al., "*The Economic and Social Modernization of the Republic of Korea*", Cambridge, Massachusetts: Harvard University Asia Center, 1980.

literacy in East and Southeast Asia didn't noticeably increase until the post-war period when mandatory primary schooling became widespread. Thus, it's reasonable to assume that this was the primary channel to literacy. Even Japan, which was the first to experience a rise in literacy in the late 19th century, saw mandatory schooling laws implemented in the previous generation. Therefore, investment in education must have proceeded rises in literacy. Yet Roderik cites 1960 enrollment levels as the impetus for growth, even though increases in literacy had reached their greatest momentum by then. This means that to investigate the source of South Korea's post-war literacy boom, one place to start would be to look for a pre-war enrollment boom.

Before moving on, an additional factor needs to be addressed. Schooling, despite the protest of social critics, is a service sold on the market[16]. It requires producers to supply it and consumers to demand it. Education is special in that most of the cost of it is borne by governments who consider an educated population as a requirement for economic growth and political order. Where the public sector has established enough schools to reasonably expect attendance, it will begin to mandate a certain number of years of primary schooling. Even in this case however, public officials walk a fine line because opportunity costs and preferences can still override policy goals. If take up is very low, enforcement can be all but impossible. Therefore, there must exist sustained demand by consumers of education (i.e. households) in order for the public provisioning of education to be utilized. There are three distinct components to this demand: The reward for education must exceed the perceived opportunity costs, the reward for education must be known, and children must have an ability and interest in learning. An affinity for long-term planning as well as placing an inherent moral value on education outside of economic benefit can cause the first component to vary, while broader social networks can help spread information about the outcomes of education. The third component is particularly fickle and rarely considered. However, students who are

[16]For an example of such an approach, see Becker, Gary S., et al., "*The Market for College Graduates and the Worldwide Boom in Higher Education of Women*", American Economic Review, 100(2), (May 2010), pp. 229-233.

the first in their family to become literate have little support when completing a frustrating assignment. With few people to help them and family members sensing their difficulty, students may give up early, deciding that education is simply something they're incapable of. Factors affecting take-up had for many years been assumed to naturally occur by development economists, but this is clearly not the case[17]. Often families hold children back because they need the extra labor in the house. Even if they don't, getting student to maintain education gains with year-round engagement is unlikely to occur. Cultural norms also prevent girls in many cultures from attending classes. Schools have had to bribe families with free lunches and clothing, and even then successes have been slim. South Korea and Asia in general thus stand out for how quickly demand responded to a growth in supply.

This study argues that the origin of this rapid take-up of education is tied to institutions prevailing in the Korean countryside in the pre-war era which stimulated demand for education much before it was adequately supplied by the South Korean government. Yet the effects on the Korean countryside were not maintained within it. The 1960's and 1970's constituted a period of rapid demographic changes. Millions moved into urban areas, especially Seoul, such that from 1966-1970 the proportion of the population living in urban population grew by 50% and had nearly doubled to 57.3% by 1980[18]. Though these people now found themselves in a new environment, they retained the same preferences and levels of human capital as they had while working in the countryside. Their high demand for education thus should be able to be traced to rural and agricultural development.

[17] See Chapter 4, "*Top of the Class*" in Banerjee, Abhijit V., and Esther Duflo, "*Poor Economics*, London: Penguin Books, 2012.

[18] Rii, Hae Un, and Jae-Seob Ahn, "*Urbanization and its Impact on Seoul, Korea*", Chung-hua Institution for Economic Research, UN NGO Policy Series, (2002), pg 1-24.

2 Theoretical Framework

The role of agriculture in development has historically been marginalized, being considered simply a traditional mode of production. Thinking in terms of economic sectors can be said to have begun with Karl Marx, who saw different stages of development based on “changes in production technology and associated changes in the system of property rights and ideology” motivated through competition between two classes[19]. Agricultural production, dominated by a feudalistic economic system, would, in this framework, be gradually replaced by industrial production as capitalists struggled with the proletariat over the means of production. However, by the time of Marx’s writing, feudalism and agriculture seemed to be becoming increasingly fragments of the past. Friedrich List meanwhile argued for domestic industrial expansion as the prime mover of all sectors, including agricultural, of the economy. He saw more of a symbiosis between the industrial and agricultural sectors. Industrial growth both increased demand for agricultural products and provided more technologically advanced inputs for the sector. Agriculture in turn held a large population that provided a market for industrial goods[20]. Starting in the 1930’s, in the footsteps of the German historical school, Allan Fisher and Colin Clark divided the economy into primary, secondary, and tertiary sectors. They presented data they purported showed that economic progress would be achieved through the transfer of investment and productivity growth followed by labor from each sector to the next. Thus governments focused on the transfer of resources from agriculture to industry, with the former seen as lacking any capability of future economic growth. The country thus able to sustain itself with the lowest percentage of labor in agriculture would have to be judged as the most advanced[21]. In light of the dynamic growth witnessed in the post-war period, an alternative conception of development was formulated by Rostow. Mainly concerned with “deceleration” of growth, he argued that declining

[19]Hayami Yujiro & Vernon W. Ruttan, ”*Agricultural Development: An International Perspective*, Baltimore, MD: Johns Hopkins Press, 1971 (pg. 11).

[20]Ibid, 12

[21]Ibid, 13

prices and income elasticities would cause stagnation in each successive sector unless technology could allow for new sectors to emerge. He however saw a need for a strong agricultural sector, not only as the driving force for predominantly agricultural economies, but also for its ability to provide food, a mass market for goods, capital investment, and a labor force[22].

Another framework popular among economists for analyzing the role of agriculture in development has been the dual sector model. Lewis (1954) stated the foundations of the model as the interaction between a larger and stagnant agricultural sector and a small, but thriving industrial one[23]. As he argued, a rural sector with a large surplus of labor may have marginal labor productivity near zero, or at least below subsistence levels. Moreover, wages are determined within the agricultural sector itself, meaning that they approximate the marginal productivity of labor in that sector alone. This is because all opportunities to use labor in agriculture have been exhausted and what is left to do has only marginal significance. The result is a large amount of excess and idle labor. With the first investments in industrial capacity in the urban area, destitute peasants would be able to increase their wage by moving to the urban sector. As they resettle, marginal labor productivity in the rural sector rises, but output remains the same. This provides for an agricultural surplus that can be invested into the urban sector. However, though industrialists had been able to take advantage of the low rates of marginal productivity in the countryside to lower wages and gain higher profits to reinvest into production, their ability to extract profits gradually decrease. The urban sector must then constantly compete with the rural sector through increasing productivity. However, as it will be argued, applying this model in Asia presents an issue since there was rarely an idle surplus of labor in the countryside. Every worker had their own role in the cultivation process and thus their departure would have caused a fall in yields. Jorgenson (1961) pushed against the assumptions of zero marginal productivity and wages that are determined through segmented sectors[24]. Since any movement of labor

[22]Ibid, 14

[23]Lewis, Arthur, "*Economic Development with Unlimited Supplies of Labor*", Manchester School of Economics and Social Studies, 22, (May 1954), pg 139-91.

[24]Jorgenson, Dale, "The Development of a Dual Economy, The Economic Journal, 71(282), (June 1961), pg 309-334.

from the agricultural to the urban sector results in a fall in output, there must be productivity change in the agricultural sector to compensate for this decline[25].

There are two main issues with the above formulation that undermine its viability, particularly in the Asia context. First, it imagines productivity gains as smooth transitions that have no institutional effects on production. However, productivity gains have been historically difficult to achieve, even with the proper incentives. When they do arrive, their effects on the various factors of production can be quite considerate. Second, it supposes a seamless transfer of labor and capital between the urban to the rural sector. Within the processes of development in Asia, the two sectors cannot be viewed as interchangeable; it expends a of of extra energy to move goods from one sector to the other.[26] Hayami and Ruttan (1971) realized the weaknesses of such a model early on and presented an alternative conception which they termed the induced development model. Under such a framework development in the traditional agricultural sector is fueled by technological inputs from the urban sector while also supporting it with an agricultural surplus. Growth in the traditional sector is induced through two basic needs: either to save labor or to conserve land. However, the researchers realized that technical advancement on its own cannot induce development. Instead, the model "involves an adaptive response on the part of cultural, political, and economic institutions, in order to realize the growth potential opened up by new technical alternatives[27]." If the institutions cannot adapt to the consequences of technical innovation, then this innovation will be stalled indefinitely. Critical components contributing to this institutional flexibility include "investments in general education" and "an effective system of market and non-market information linkages[28]". The researchers borrowed and adapted extensively from previous models of development to build this framework. Interestingly, they claimed that their focus on institutional change was inspired by Marxist analysis.

[25]Hayami & Ruttan, 23
[26]Ibid, 24
[27]Ibid, 4
[28]Ibid, 5

2.1 Labor Intensive Industrialization

Labor intensive industrialization (LII) has been advocated for as an alternative to the dual sector economy; in many ways it is a variant on the induced development model. LII is based on the argument that Asia used labor, rather than land or capital, as its source of competitive advantage[29]. The need to conserve a particular factor of production was also a key motivation in the induced development model. One major reason that Asia may have had an abundance of labor, and hence a need to conserve the other factors, is the spread of the rice crop. Vollrath (2011) connected the abundance of labor to the labor-intensive cultivation of rice. In cultivating rice, he argued, one would discover that the "diminishing returns to labor are less pronounced"[30] in this crop. The reasons for this will be explored further, but for now it's important to note that marginal labor productivity will take much longer to approach zero in the rice economy than in the classically modeled agricultural economy. As a result, more labor can be employed than in with alternative crops. The relative abundance of labor encouraged the adoption of certain techniques of production rather than others, resulting in a path of technological development different from the capital and land intensive one that formed the basis of Europe's industrial revolution. Specifically, labor intensive industrialization encouraged the diversification of economic activities, investment in skill, and sustained economic inclusiveness. This speaks to the adaptive institutional response advocated by the induced developed model.

Before Vollrath, the role of rice in promoting LII was formulated Francesca Bray (1986), who proposed a distinct path of development for rice economies when she suggested that rice cultivation encourages "alternative paths of technological development"[31]. Bray argued that this concept better explained the historical narrative of development within Asia than did neoclassical economics. For instance, the question of the cause of economic divergence between China and Western Europe is a major one within

[29] Austin, Gareth, and Kaoru Sugihara, "*Labour-intensive Industrialization in Global History*", New York: Routledge, 2015.
[30] Vollrath, Dietrich, "*The Agricultural Basis of Comparative Development*", Journal of Economic Growth, 16(4), (Dec 2011), pg. 343-370.
[31] Bray, Francesca, "*The Rice Economies: Technology and Development in Asian Societies*, Oxford: Basil Blackwell, 1986.

economic historiography[32]. However, Bray termed the divergence in living standards between them a ”red herring” in the overall study of economic history. Instead of viewing the increase in living standards in a linear fashion, Bray instead focused on the technological paths underpinning these living standards. Although it would later help bring about fast paced growth, this was not the economic goal of actors within the labor-intensive economy. Instead, it was to transform production to expand the potential of rice cultivation to absorb more labor. Thus, the technological apex achieved by China in the 13th century and the subsequent decline was the result of a continuing transformation of patterns of production rather than of a collapse. Thomas C. Smith's (1959) seminal study into Japan's agricultural transition during the Edo period also implicitly focused on technological paths of development by discussing exchanges of labor and capital that fueled the "growth of the market"[33]. Specifically, it was the labor requirements of rice which encouraged both economic inclusion and entrepreneurial behavior. Hence, though Edo Japan may have had comparably low living standards, it was engaged in an agricultural revolution, though of a different sort, contemporaneously with England.

Meanwhile Douangngeune, Hayami, & Godo (2004), focusing on differences in rice yields, argued that Thailand's abundant land resources resulted in "slower educational development"[34]. While the government invested in education, take-up was relatively slow, something the authors attribute to abundant land which "could be readily exploited by traditional technology." Land abundance, combined with labor scarcity, may have also fueled growth in the early United States according to Habakkuk (1962). He argued that with a greater opportunity cost to abandoning agriculture on account of land abundance, industrial wages increased, resulting in the greater substitution of labor for capital[35]. Agriculture thus, outside of

[32]Pritchett, L, ”*Divergence, Big Time*”, The Journal of Economic Perspectives, (1997) 3-17; Acemoglu, D., Simon Johnson, & James A. Robinson, ”Reversal of Fortune: Geography and Institutions in the Making of the Modern World Income Distribution”, Quarterly Journal of Economics, (2002), 1231-1279.

[33]Smith, Thomas C., ”*The Agrarian origins of Modern Japan*, Stanford: Stanford University Press, 1959.

[34]Douangngeune, Bounlouane & Yujiro Hayami & Yoshihisa Godo, ”*Education and Natural Resources in Economic Development: Thailand Compared with Japan and Korea*, Journal of Asian Economics, 16, (2005), pg. 179-204.

[35]Habakukk, John, ”*American and British Technology in the Nineteenth Century*, London: Cambridge University Press, 1962.

furnishing a labor force for the industrial sector, shapes the development of this sector.

An argument based on land abundance however differs from that of one based on botany, though there are important interactions between the two that will later be mentioned. There are several taxonomic characteristics of rice which may affect paths of technological development. Though upland varieties exist, the majority of rice is grown in paddies flooded by water ranging from about 30 centimeters to two meters in depth in the case of floating rice. Land that has been worked as paddy is usually highly valued and the conversion of land from dry field to wetland has been a common way to increase yields. Like in England, where complex rules governed access to pasture, complex relations and disputes over access to water were embedded in social relations. Not only was access necessary, but water levels needed to be managed through systems of irrigation, drainage, and flood control. A major advantage for Asian rice cultivators compared to Western cultivators of dry grains was that they did not require a crop rotation system in order to prevent nutrient depletion. The nutrients from the water and naturally growing algae however kept paddy land fertile while rice was being cultivated. This allowed for the same plots to be used year-out. Moreover, rice does respond well to intercropping as the planting of a winter crop requires the paddy to be drained and reworked.

While many other relevant characteristics of rice cultivation will be explored, the main argument is that rice is distinguished as a labor-intensive crop and thus engenders a labor-absorbing path of development. Labor intensive is a relative term detailing a process of production that fulfills two conditions: First, increasing the supply of labor results in a commensurate increase in land productivity so that labor productivity remains constant in the manner described by Boserup (1965)[36]. This is the case in most pre-industrial economies, but simply put, "returns to labor diminish more slowly in rice production than in wheat production" (Vollrath, 2011). Note that subsequent discussion of land and labor productivity will

[36]Boserup, Ester,"*The Conditions of Agricultural Growth: the Economics of Agrarian Change Under Population Pressure*", London: Allen Unwin, 1965.

be referring to its value within rice cultivation; it will be noted if the comparison is for any other agricultural commodity. Second, any increases in capital inputs are ones that preserve rather than replace labor inputs, such as irrigation as opposed to the ox plough. This is not to say that other factor interactions don't exist in rice cultivation. In early stages or when land is abundant, increases in labor supply may result in constant land and labor productivity. In a highly interconnected economy, increasing labor supply may decrease land productivity as individuals optimize to work in rural industries. Modern cultivation might also employ labor replacing capital, such as tractors, when resources allow. What matters however is that they are all derivative of the labor-intensive system. This then sets the frame for future development.

The major reason why rice becomes a labor-intensive crop is the way that the cultivation system adapts to increasing labor. Within the range of a few weeks, land has to flooded and the rice sown individually while wading through deep water and thick clay. In the next couple of months, water levels need to be maintained and weeds removed until when the plants can be individually harvested. Moreover, putting more work into any of these steps results in a much higher yield. Rice can initially be grown in nurseries, it can be planted in a narrower timeframe, it can be more tightly sown, weeds can be better removed, organic fertilizers can be produced, it can be harvested faster to allow for a second crop or dry grains to be planted, and new seed varieties can be developed among other techniques. Most of these inputs are easily divisible, straightening bottlenecks in the process. The abundance of labor meanwhile keeps wages low and makes labor-replacing capital ineffective.

The labor intensive process encourages a path of technological development with four key components: a rise in the carrying capacity and hence productivity of land, labor diversification, the accumulation of skills, and the tendency towards economic inclusion. What is meant by a higher carrying capacity of land is that, given some percentage of arable land cultivated with rice, the corresponding expected population density in that area will be higher than if the rice was replaced with dry grains. This doesn't mean that all regions which grow rice will have higher pre-industrial population densities, only that they have the potential to. Land constraints, primarily topographical, but also political and social, will determine whether land is abundant and hence whether labor-intensive rice cultivation will take advantage of the higher carrying capacity. Higher population density can have several benefits. It can encourage the creation of a centralized state through higher tax revenues which can protect against invasions, enforce a legal framework, and maintain infrastructure. Since the flow of goods will be larger, it may also increase the number and the relative integration of markets. Finally, higher population densities in rice cultivation promotes the disintegration of large landholdings in favor of family cultivated plots, unlike that of dry grains. Monitoring workers is difficult and skills (discussed later) are required to be developed so that revenues can be maximized. Consequently, tenant relations replace manorial much earlier.

Labor diversification, or what Francks (2000) terms the "pluri-active household"[37], is another by-product of labor-intensive cultivation. Specifically, the seasonal demands of labor allow for slack periods when activity outside of rice cultivation can be pursued. This can include the cultivation of crops outside of rice, but might also influence the emergence of rural industries such as textiles. If markets are relatively integrated, then this allows families to benefit from productivity growth in a growing industrial sector while remaining engaged in agriculture. This provides added stability so that in the case when agricultural prices collapse, households could more easily transfer their labor to industrial activity. There was little separation of the worker from their means of production. Certainly this was less the case once interest rates fall and urban economies of scale were taken advantage of, yet even then the majority of firms tended to have fewer employees, reflecting the continuity of the household framework.

The third component was the creation of a skilled labor force. Agricultural labor, argued Saito (2013), was not "abundant, homogeneous, and disposable", but conditioned by experiences with cultiva-

[37]Francks, Penelope, "*Japan and an East Asian Model of Agriculture's Role in Industrialization*", Japan Forum, 12(1), (2000), pg. 43-52

tion and social institutions[38]. It was not abundant and it in fact often experienced shortages in the peak growing season. Labor was also not disposable, but embedded into social relations reinforced by obligations in mutually beneficial exchanges. Focusing on the supposed homogeneity of labor, Saito argued that the continual refinement of skill and technique within the rice economy imbued rural workers with an affinity for industrial work in the post-war. Cultivators had to learn how to best work their land, negotiate rights to and maintain complex irrigation facilities, and invent new intercropping patterns in order to support an increasing population. This experience may have led to a better understanding of the benefits of long-term investments (especially in education), innovation, product differentiation, time discipline, and cooperation among others. The capacity of rice economies in the post-war, even during their "development stage", to produce technically complex goods for export, including cars and electronics, might be argued as a direct consequence of the development of skill in agriculture.

The final component in the model relates to inclusiveness in the relationship between tenants and landlords. This point may come as a surprise since social relations in traditional Asian rice economies were certainly not based on a concept of equality of outcome or even that of opportunity. Privacy was tenuous. Mentions of banishment and ostracism from social superiors were feared. The majority had no say in community affairs. Yet membership in a rigid social hierarchy presented opportunities with itself within the rice economy. Labor requirements meant that the most well-to-do depended the most on the diligent and skilled work of tenants, or often extended family members. It was incumbent on them to ensure that those working their fields were the most skilled, giving them an incentive to transfer techniques. During the off-season, landlords would have to decrease their rents to encourage tenants to drain and work the land. As a result of these close ties, landlords saw it in their interest to provide access to capital to their cultivators. By having them learn how to use more advanced techniques on their own farms, they would be

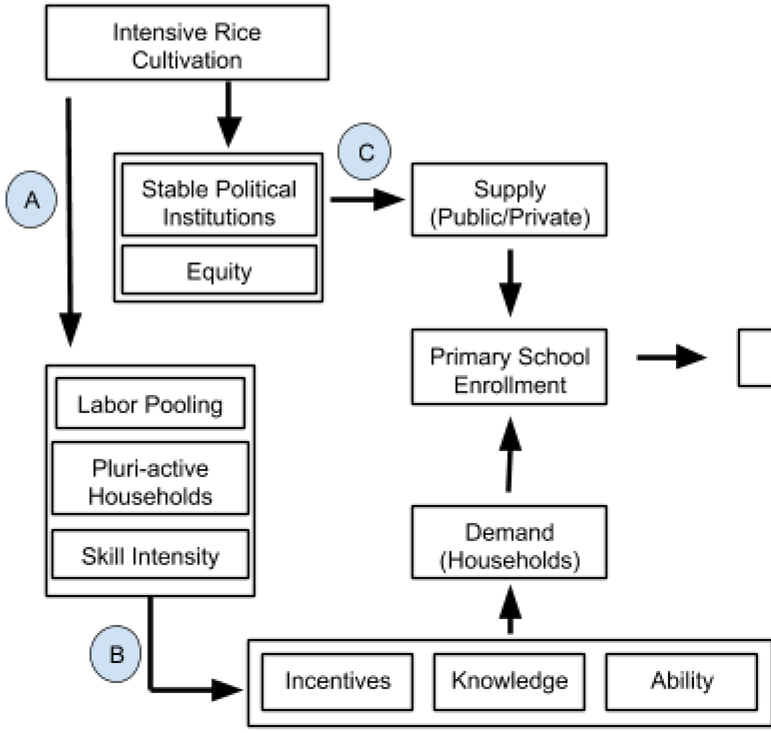
[38] Saito, Osamu, "*Proto-industrialization and Labor-intensive Industrialization: Reflections on Smithian Growth and the Role of Skill Intensity* in Austin, Gareth and Kaoru Sugihara, eds., 2013

more able to provide more productive labor when it was most necessary. This would gradually spread to the sharing of power looms and other capital for the various industries the pluri-active household engaged in. Thus, though land may have been unequally divided, the organization of labor preserved a high level of economic inclusion.

We use this path of technological development to model growth in colonial Korea. Increases in carrying capacity, labor diversification, skill development, and economic inclusion, as the pre-requisites for development in the rice economy, are hence the criteria used to judge economic growth under Japanese colonialism. The question then is whether these criteria developed further under Japanese rule than they would have without it. If Japanese intervention can be shown to have had a positive influence on these four parameters compared to what would be the alternative, then one can argue that the Japanese established the necessary conditions for post-war growth. Living standards measured in purchasing power may thus be decreasing, but this would be a "red herring" according to Francks. The changes would either be caused by random exogenous events or by the criteria reaching different stages of development. If the other criteria experiencing expansion, then this will be the main cause of long-term growth in living standards. It is nevertheless still crucial to connect these criteria to actual growth in the postwar. Evidence is hence provided from secondary sources that estimate the significance of the contribution of these components to post-war growth is provided in the final chapter.

The overall theory used to justify the argument presented in this thesis can be summarized using the above diagram. Intensive rice cultivation can result in social reorganization which allows for more efficient production. This process, labeled A, requires the society to have a certain amount of flexibility and openness to entrepreneurship. Otherwise, economic stagnancy can overtake the rice economy resulting in agricultural involution. This we term the high level equilibrium trap. Korea was able to avoid the trap for several reasons, principally from the relative weakness and involvement of the elite in agriculture.

Figure II: Labor Intensive Growth



Korea under Japanese colonialism offers a relatively unexplored opportunity to test the claims of this model. One glaring issue with it is that not every rice economy has been equally successful at translating labor-intensive industrialization into development. Asia offers some of the world's most glaring inequalities in prosperity between countries, where crossing a border may seem like entering a different world. Even historical differences between advanced economies such as Japan and China put into question the existence of a model of growth that supposedly doesn't require any external forces to push through its various stages. It must then be the case that other factors, whether randomly present at the outset, or the result of exogenous forces, allowed for some rice economies to succeed in the major transitions by overcoming certain bottlenecks in the model. Korea is a good context to examine what these bottlenecks could have been and how they might be overcome. It is not clear how successfully Korea, not having undergone Japanese colonialism in the early 20th century, would have overcome bottlenecks to develop in the post-war era. It may have in fact done just as well if not better given the disruptions of colonialism. However, it could have also done worse, perhaps resembling the less developed economies of Southeast Asia with their lower education levels and greater corruption. To ideally test the effectiveness of the treatment, i.e. the set of Japanese interventions in the agricultural economy, a treatment and control group should be constructed to control for selection bias and confounding variables, with differences between the two groups examined after the experimentation period. Unfortunately, neither would a randomized control trial have been feasible, nor is there the semblance of historical experimentation. To evaluate claims made about an alternative Korea, the project asks whether the peninsula, at the onset of Japanese colonialism, more closely resembled the lower Yangtze delta in China or a Japan simply a generation or more behind. If the former, then it's likely the push from Japan was necessary to set Korea on the trajectory we find it today. If the latter, then at best Japan simply accelerated the pace of growth in Korea; at worst it may have stalled it from catching up to Japan sooner.

2.2 Role of Japanese Colonialism

Myers & Yamada in The Japanese Colonial Empire (1984) loosely identified five initiatives of Meiji Agrarian Policy that were transplanted from mainland Japan to the Korean Peninsula and implemented over the course of the colonial period. These were (1) a land survey, (2) opening of new land, (3) introduction of new technologies, (4) investment in market and transportation infrastructure, and (5) the establishment of local agricultural bureaus.

The land survey initiated in 1911 and completed in 1918 not only defined boundaries and ownership of land, but linked this registry to a national database of citizens to allow for continual updating of records. The survey served several goals of imperial Japan. First and foremost it allowed Japan to extract more wealth through land taxes, especially from properties that had been previously hidden under Joseon surveys (up to 50 % of land)[39], and to simplify the tax code. It also allowed wealth to be extracted more

[39] Yoo & Steckel 45

reliably by replacing a series of output taxes with a single land tax. While the previous Korean government had determined state expenditures based on revenue for a specific year, the Japanese sought a tax base that would allow them to make long-term financial commitments. The tax system they implemented thus mirrored the kokudaka system used during the Edo era by examining land characteristics to assess a tax based how much rice the land could be reasonably expected to produce. This also added stability for household expenditures since the sum that had to be paid was already known. Such a reform may have encouraged cultivators to work land more intensely since they would pay less of their income in taxes given a larger harvest. The Japanese government also stipulated that the land tax had to be paid with cash, as opposed to rice as had been traditionally the case. This condition gave cultivators more incentive to sell more of their goods in the market for cash. It also made it easier to diversify away from rice to other produce such as beans or fishing, or even rural industry such as sericulture.

A major criticism coming from Korean national historians was that the land survey allowed for expropriation from illiterate peasants to Japanese settlers and corporations[40]. There are several pieces of evidence to support this claim. Even before colonization, the Japanese government had been pushing to allow Japanese citizens to purchase cheap land in Korea. Though few Japanese settled in the peninsula, by the close of the colonial period, Japanese settlers, corporations, and the colonial government held up to a quarter of land[41]. Japanese officials also used the survey to deduce which land belonged to government bureaucrats and members of the royal family, later confiscating it and selling it to corporations such as the Oriental Development Company. However, other historians dispute this claim on two charges: (1) the transfer of land to Japanese landlords that did occur was primarily caused by the depression of the 1930's, and (2) where Korean landlords were supplanted by Japanese ones, their impact was largely negligible[42]. Though land markets were not well established in the pre-colonial period, it is certain that "tenure was

[40]Shin, Peasant Protest and Social Change in Colonial Korea (40).
[41]Sorensen, Clark W. Korean Studies 20 (1996): 262-65. http://www.jstor.org/stable/23719613.
[42]Gragert (2).

very insecure in the late Choson dynasty" such that according to Hong Songch'an's (1986) study of land belonging to a member of the Korean royal family, between 1896 and 1910, 28 out of 37 fields changed tenants at least once[43]. With such a record, the early colonial era seems to have ushered in a period of stability: between surveys from 1913-1917 and those from 1918-1927, only a 2.4% increase in landless tenants occur[44].

Most significantly however, the land survey conferred legal property rights in land to their respective landowners. In presenting a natural experiment in the Japanese territory of Palau, a collection of islands in the Pacific, Yoo & Steckel (2010) argued that the establishment of individual property rights there by the Japanese government promoted "robust economic development". Though Palau had not been viewed as having much economic potential either by the Japanese or previous colonial forces, it was the only state in Micronesia where boundaries of private lands and land registers were constructed before the war halted these efforts[45]. Even within Palau, they argued, one sees differences between the three states whose land register records were misplaced or lost in transit and the rest of the island county where the rights were upheld in US courts[46]. Moving to Taiwan and Korea, they argued that well-defined rights in those two colonies "secured land taxation and enabled farmers to obtain bank loans from capital improvements, principally irrigation systems." The usage of land as collateral allowed for access to credit to households who had never before engaged with the modern financial system. Private interest rates fell from as high as 50% to between 10%-20% by the end of the colonial period[47].

The standardization of property rights may have also encouraged the growth of literacy rates since the deed to one's land was no longer based on verbal agreement or who worked the land, but stored in a physical document that needed to be updated when changes were made. The ability to sign one's name

[43]Shin (37)
[44]Ibid, 60
[45]Yoo Steckel (7).
[46]Ibid, 8.
[47]Ibid,38.

would have been important in affirming ownership. It also set a new stage for the relationship between owners and tenants. The standardization of these rules allowed for large peasant protest movements to form during the colonial period.

Between 1910 and 1940 the amount of paddy land in Korea grew by over 200,000 hectares and the amount of double-cropped land grew by more than 250,000 hectares, or 250%. The result was an increase in annual rice production from 10 to 22 million koku within the colonial period, amounting to a 2.31% increase annually. Others like Sub Park, find annual increases as high as 3.8% during the 1920's and 1930's. He argued that although about 18% of this growth in output was a result of increases in paddy land, the remaining 82% originated from growth in land productivity[48]. Thus, though paddy land increased by 30.3% over from 1911-1939, labor productivity rose by 80.6% in the same period.

2.3 Pre-Colonial Conditions

Land carrying capacity, that is, land productivity and its interaction with labor productivity, is the first criteria to be investigated. It is certain that rice culture had, by the arrival of the Japanese, already reached a critical point in Korea. In the capital Kyonggi province, Japanese surveyors led by Fusagirou Kabayashi judged that in 1907 just under 3/4 of arable land had already been cultivated. Dividing the province's mainland into 58 blocks, they grouped land into 9 categories. Two of these comprised all currently cultivated land: paddy and farm land. Four of these were areas considered not arable: mountain regions, regions with sandy soil, swamp, and coastal wetlands. The final three were regions which were "not yet cultivated" and included mountainous regions, land near rivers, and land near the sea. Thus, they estimated that 74.01% of arable land had already been cultivated by 1907. Such measures may not be accurate because of disagreements on definitions and whether land really was arable. However, they are likely to

[48] A Cliometric Revolution in the Economic History of Korea: A Critical Review (90).

be precise in their comparison with domestic Japanese calculations. When making their categorizations, the surveyors would have been familiar with more intensive methods of cultivation, such as terracing and transplanting. There is a possibility that they may have overestimated the amount of arable land (underestimating area cultivated) since in later decades the government which commissioned their research would push for the increased cultivation of marginal lands.

On their own, rice paddies occupied 49.31% of all arable land and constituted 66.67% of all cultivated land, i.e. 145,781 cho (1,446 km2). Of the 47 mainland regions (which included the closest islands), five (10.64%) had already put 100% of arable land under the plow. They all had variable amounts of both types of fields, mountain areas, and cultivated areas. One possibility that they were considered to have had their entire arable land cultivated was because they were all regions bordering other provinces and thus in the grid made by the surveyors had much less land to assess.

The remaining third of cultivated land was occupied by various other fields and gardens which grew other grains such as wheat and millet, soy beans, and mulberry leaves for silkworms, among others. The vast majority, 71.78%, of all land however was marked as a mountain region where agriculture could not be established. In some districts that percentage reached almost 95%. The data doesn't seem to suggest that having a larger mountain region encourages a high proportion of arable land to be cultivated.

Comparisons are difficult to draw because of changing definitions, but a Japanese government account in the same year as the survey declared that around 2.9 million cho, or about 28,760 km2 of rice had been cultivated in that year within Japan. Kyonggi's cultivated area thus was larger than that of any Japanese prefecture outside of the rice center of Niigata, which counted 166,780 cho of rice sown that year. By one measure of arable land which combined pastures, forests, fields, and land for buildings, paddy land in Japan constituted around 20% of arable land in that same year. The combined percentage for both farms and cultivated fields was 37.24%. Taking another measure which focused on natural configuration combining lowland, upland, and hill land, rice occupied 29.15% of arable land. Japan had by this period begun to import large quantities of rice from outside the country, particularly from Korea.

Taking a larger look at land productivity changes over the period of Japanese colonialism, one sees what appears to be stagnancy is land productivity. It's only in the 1930's that land productivity regularly exceeds 10 koku (180.4 liters) per cho (2.499 acres). Moreover, productivity seems to be of a cyclical nature with minor booms and busts reflecting the cyclical nature of the market. There are several ways productivity is influenced by market cycles including impacting factor inputs through fluctuations in factor prices. Nevertheless, by the late 1930's productivity seems to have experienced a boom with 1937 recording a harvest with 15.3 koku per cho (a 100% increase from when records begin in 1910). An initial expansion from 1910-15 is followed by stagnation and contraction 1916-21 (though productivity remains above the 1910-12 levels). Growth then resumes and is consistent throughout the period outside of a contraction in 1928-1930.

Though land productivity rose in Korea during the colonial period, it barely grew as a percentage of productivity in Japan, which by 1933 had grown to 23.26 koku per cho. The data does not support accounts that productivity in Korea was approaching Japanese levels during the colonial era. This result is surprising given the initial low levels of productivity in Korea which should have been easier to increase given Japanese experimentation and investment in agriculture on the peninsula. However, comparing productivity contemporaneously between the two countries might be the most appropriate action. Japan by the early 20th century was already in the midst of its own industrial revolution and more advanced cultivation methods generating the greatest increases in land productivity may have simply been impractical in the more traditional Korean countryside.

From 1886-1896, land productivity in Korea cycled between 50%-60% of those in Japan(Japanese levels were mostly stagnant). This is followed by a collapse of Japanese agriculture followed by a reemergence at a higher level of productivity in 1898. The ratio then cycles between 40%-50%, with Japanese productivity gradually increasing before new data emerges for Korea. Given that Korea was in many respects behind Japan in agricultural methods, it makes much more sense to compare colonial growth to growth in Japan before the 1898 boom. Considering that this period was stagnant, any other 10-year period in colonial Korea compares favorably to it.

There are many possible causes of this rise in land productivity, though they can be divided generally into two categories. It may be the case that more labor is being imputed into each plot of land (i.e. labor-absorbing agriculture) or that labor productivity has increased, allowing for a constant number of cultivators to extract more rice from each plot. Figure 4.6 looks at the first category by plotting the number of households engaged in agriculture on land productivity during the entire period. In labor-absorbing agriculture, increases in labor supply should result in a linear rise in land productivity. While this does seem to explain some of the variation in land productivity, the second category of growth, depicted in figure 7, seems to be a more accurate portrayal of what actually occurred. That is, growth in land productivity in Korea was caused almost exclusively by growth in labor productivity rather than by an expansion of labor supply. However, this seems to have been a transition during the early colonial period. Looking only at the period 1910-1918, the explanatory power of labor supply on land productivity is about as strong as that of labor productivity.

For new land to be opened, new irrigation systems had to be built and expanded. These were often financed through loans issued by the Japanese government to those who benefited from the new systems. The fact that there was new land to be opened signaled that Korea as a whole didn't have as intensive of a rice system as Japan did. In fact, average yields were 1.43 metric tons of rice per hectare in 1920 (which compares with the statistics in the agricultural survey) compared with 2.91 in Japan. The expansion of rice to new areas required more complex technologies. There are two distinct types of technologies that are important to discuss: new more productive inputs, and new techniques to use current inputs. In the former were new seed varieties and fertilizers that would allow rice to grow in cooler climates. New seed varieties were created at agricultural associations and experimental stations around the country and distributed to landlords first and then to owner-cultivators, ordinary farmers, and tenant farmers. One effect of the opening of trade and increased interaction with Japan is that rice became a globally traded commodity. Japan looked to Korea as its grain basket as prices were much lower there than for domestic rice. This became especially a priority after rice prices rose and chaos erupted in the streets of Tokyo in the 1918 rice riots. New infrastructure had to be developed to better transport this rice and the establishment of the Seoul-Pusan railroad cemented this link, although the northern portion of the country would continue to be relatively isolated. Finally, the establishment of provincial and county level agricultural bureaus created a direct link between the state apparatus and he rural population that would, as Kohli argued, create the deep state.

To return to the discussion on school enrollment rates and whether they were affected by Japanese interventions in agriculture, a time period of growth needs to be established. Post-war enrollment rates rose from 59.6% at the conclusion of the Korean War in 1953, to 77.4% in 1955, and 86.2% by 1960 (those cited by Rodrik), clocking in at an annual growth rate of 5.41%[49]. As rapid as this may seem though, this was actually slower, or at least similar, to growth in the 1930's, which moved from 20.1% in 1933 to 42% in 1939, averaging a rate of 13.07% annually (see Figures 1.1 & 1.2)[50]. An earlier peak in growth also occurred in the period 1919-1924 when enrollment increased from 4% to 16.4% (averaging 32.49% annual growth). Though schools existed before colonialism, statistics on enrollment are currently

[49]The Economic and social modernization of the Republic of Korea / Edward S. Mason.

[50]Colonial enrollment data comes from a 1940 report published by the Governor-General's Office titled Chōsen Shogaku Ichiran. Shōwa 14 nendo (朝鮮諸学校一覧. 昭和14年度) accessed through the Japanese National Diet Library Digital Collections. To calculate the percentage of total elementary age students enrolled it was calculated that 12.51% of the total Korean population was between 6-9 years of age (inclusive) in 1940 and this proportion was extrapolated to previous dates. No large spike in population growth occurs in Korea until the post-war, so one would expect this proportion to remain relatively constant.

unavailable. Instead, a disambiguation of literacy by age cohort is our best statistical insight to education under Joseon Korea. It does show movement in the pre-colonial era which will be a topic addressed later. An additional factor that the data might be missing is the closure of private schools by the Japanese colonial regime. Though before the colonial era most schools were established through private means, a 1915 ordinance required all private schools to be certified by the colonial government. The result was a drop in the number of schools from over 2,000 in the first few years of colonial rule to around 600 by the mid-1920's. However, it seems that the establishment of new public schools was able to pick up the slack: the proportion of Koreans attending schools increased annually from 1913-1941.

While Rodrik ties the post-war economic boom to high enrollment rates in 1960, the main accomplishment of primary school, establishing literacy, had already succeeded by then. There's a simple logic of why the post-war surge in enrollment rates was not the cause of a tripling of literacy rates by 1960. Literacy is commonly reported as adult literacy, i.e. for everyone over 15 years of age and above. Therefore, no one born before 1945 would be counted in the 1960 measure. Primary school in Korea traditionally takes four years to complete, enrolling students from the ages of 6-9. Thus to be born on or before 1945 and educated during the post-war surge, thus influencing literacy through enrollment, one would have to be born 1939-1945. To imagine that such a relatively small cohort was able to by itself cause a tripling of the literacy rate would not be logical. The baby boom in Korea would take a few more years to kick off; if anything, new births would have fallen during the war. What is more likely is that they had help from an earlier cohort with similarly high enrollment rates with whom over the next 15 years became the majority of the population. This cohort, educated during the 1933-39 boom, would have been born around 1927-1933. Thus, the education boom in post-war South Korea was founded on primary school enrollment during the late colonial period.

Intensive rice cultivation doesn't specifically provide for either a supply or demand for education.

Rather, it stimulates social structures and attitudes which set the stage for demand and supply to quickly respond to each other when changes occur. First, intensive rice cultivation exhibits constant marginal returns which encourages farmers to work their fields throughout the year. Compare this with the peasants of Europe who spent months idle because nothing could be planted in the off-season. Moreover, they were faced with much fewer options during the growing season, with limited opportunities for intensification. This produced a distinct Asian work ethic which focused on the benefits of higher labor inputs throughout the year. A similar approach to education would be necessary. Second, intensive rice cultivation, just as education, calls for long term investments in skills and capital. New irrigation systems, flood control systems, draining systems, methods of transplantation, planting, weeding, new seeds, fertilizer, and many other inputs pose risks and tradeoffs, with some output foregone in order to ensure better harvests in the future. Third, intensive rice cultivation like education is a social process. Entire villages would need to work together during the harvest as all extra labor was pooled together and worked on various fields in a succession based on communal planning that had occurred during the planting season. Moreover, many of the capital inputs required communication and cooperation among village members in order to be successfully implemented. Similarly, the idea that it takes a village to educate a child requires similar levels of communication and cooperation. A youth seeking education would find much greater success learning in an area where other educated people reside. Intensive rice cultivation therefore offers a meeting of supply and demand for skill education. On their own, these skills might not include literacy among them. This study argues that it was the opening on trade and the commercialization of rice which established literacy as a new requirement for economic success.

3 Data

3.1 Literacy

The widespread definition of literacy and that used by IGOs such as the World Bank and UNESCO (and commonly adopted by NGOs) is the proportion of those 15 years of age or older who can read and write basic statements about their life. Variations of this definition occur, most notably being the ability to sign one's name, which was commonly in use is regions where the former definition was much too stringent. For Japan, which has multiple writing systems, Kanji and Kana (i.e. Hiragana and Katakana), the term is generally more ambiguous. Luckily, there are clues on interpretation within the terminology. The term which Japan uses to mean literacy, 識字, and in older documents more commonly 讀ミ書キ, has a more definite meaning than that of the more fluid 'literacy' in the west. 識字, or shikiji, literally means differentiating characters, meaning the Chinese-originating kanji historically used as a style of higher society compared to the more commonly known 'kana'. 讀ミ書キ is even more specific in meaning the ability to both read and write. On top of this, the census data from 1930 differentiates between being literate in kana or in Korean hangul. The question that's left is what consists the ability to read and write. Different definitions, from being able to read and write one's name, to understanding newspapers (and replicating) newspaper articles change the interpretation of different literacy rates. When dividing literacy rates by age groups it's seen that about a fifth of 6-9 year olds in Korea were able to read either Kana or Hangul. The standards used thus must not have been too challenging with only a few years of schooling (indeed just over a fifth of elementary school students were enrolled in classes), perhaps comparable to the current standard of composing and reading basic statements. This is useful for interpretation, though it poses no concern in the regression model since all of the literacy data is sourced from a single document (i.e. the 1930 census). If one views the enrollment boom of the 1930's as the result of the meeting of the supply with the demand for education, then the question becomes two-fold. First, was supply, or demand, or both that stalled until this period? Second, what changed in the environment that allowed for a new equilibrium to emerge?

This study looks at predictors of literacy rates in 1930 and primary school enrollment rates in 1935 on the county level. Though literacy rates on the county level were previously calculated by Hong & Paik (2017), new literacy rates, from hereon termed AKLR (Adult Korean Literacy Rate) were estimated for two main reasons. First, instead of calculating the total literacy rate[51], this study looked at the adult (i.e. 15 years and older) literacy rate. As explained above, this is the more common metric used by the World Bank. It may also give a better picture of the effects of public and private investments in education since the majority of those under the age of 15 are still accumulating literacy skills. Figure 2.1 depicts data on literacy rates for male Koreans from the 1930 census[52]. While in the older age groups the graph shows would would expect in a country where literacy is rising, namely that age age decreases literacy rises. Yet literacy hits its maximum in the 20-24 age group before the pattern reverses. Literacy declines somewhat between the 20-24 and 15-19 year old group before considerably falling in the youngest two groups. This trend is corroborated by independent census research: Figure 2.2 depicts the literacy rate for Koreans in Keiki province, the historic center of education in the peninsula centered around the capital, by age group. Critics of the colonial regime might use this to argue that the Japanese were repressing a pre-colonial trend in growing literacy rates. This is certainly a possibility, however the timing makes it unlikely. The Japanese sought to close advanced schools in the first decade of colonial rule which would have impacted the 20-24 age group the most. By the time the members of the 15-19 age group were going to school in the early 1920's, elementary school enrollment was encountering its first major expansion.

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[51]More accurately, 6 years and older, as reported by the 1930 census.

[52]Data provided by Fight ot Justice: 日本軍「慰安婦」— 忘却への抵抗・未来の責任 (Fight for Justice: Nihon Gun 'Ianfu' — Bōkyaku e no Teikō Mirai no Sekiin), a Japanese organization dedicated to preserving the memory of comfort women in the Japanese Army. Data was slightly altered for more clarity and to remove Japanese terms. http://fightforjustice.info/?page$_{i}d = 3174lang = en$.

Moreover Japanese residents in Korea, although having a much higher literacy rate, display the same trend as do native Koreans (Figure 2.3), reaching a peak literacy in the 20-24 age group. On account of these irregularities, this study, in estimating AKLR excluded those under 15 years of age[53]. Secondly, this study sought literacy rates for just Korean natives, disaggregating them from the Japanese resident community. This is to address internal dynamics of the demand for education in Korea and to prevent high Japanese literacy rates from influencing their effect.

Though ethnic data was reported on the provincial level, it wasn't available on the county level. Thus, rates had to be calculated for each county based on extrapolations of provincial data[54]. Census data for each county provided statistics on the number of people literate in Hangul, Kana, both, and neither. Unfortunately, the data was not categorized by ethnicity or age. In order to only count Koreans, only the numbers for both and Hangul were used since the number of ethnic Koreans who could only use Kana were negligible. The census also provided county population data by age such that the population of adults 15 years of age and older could be constructed for each county. However, three issues remained with the data. First, there may have been Japanese who were literate in both Hangul and Kana. Second, the county literacy data did not distinguish by age, allowing literate 6-14 year-olds to be counted. Third, the county population data did not distinguish by ethnicity. To address these issues, provincial data was extrapolated to the county level[55]. This was used to produce an estimate of the percentage of Koreans 15 years of age or older in each county who were literate in Hangul. The steps were repeated to construct separate measures for male and female literacy.

To cross-check the accuracy of these estimates, the AKLR was compared to that provided by Hong

[53]As a result the literacy figures in this study are generally greater than those recorded by other studies.

[54]The 1930 (Shōwa 5) census was accessed through the Japanese National Diet Library Digital Collections. 13 separate reports were published by the Governor-General's Office (朝鮮総督府), one for each province, under the title Chōsen Kokusei Chōsa Hōkoku. Shōwa 5 (朝鮮国勢調査報告. 昭和５年).

[55]To do so, the percent of Japanese literate in both Korean and Japanese, the percentage of Koreans under 15 years of age, and the percentage of literate Koreans who were under 15 years of age, were calculated from statistics provided for each province. The same proportion was then equally distributed to the county level.

& Paik (2017)[56]. The researchers recorded county-level rates by disaggregating literacy in Japanese, Korean, and both languages. However, they did not estimate literacy by ethnic group nor did they calculate the adult literacy rate, instead sticking with the methods used by Japanese demographers. To cross-check the data, literacy rates for Korean and both languages on the county level were combined and plotted against AKLR. Figures 2.1, 2.2, and 2.3 show the results. The rates between counties are very similar with R2 between 0.96 and 0.97. Since those under 15 years of age were excluded, the vast majority of counties in the AKLR set had higher literacy rates than those in Hong & Paik[57].

One observation was that when AKLR was regressed to predict rates from Hong & Paik, the regression coefficient was not equal to 1. If the coefficient were to equal 1, then it would be as if AKLR deducted a random portion of the rates from Hong & Paik for each county by excluding Japanese and those under 15. Since the coefficients for all three regressions were between 1.3 and 1.4 however, the amount deducted was not random. Since AKLR rose faster, those counties with the highest AKLR saw a lower decrease in literacy by eliminating Japanese and those under 15. Those groups must have then made up a much smaller percentage of the literate population than they did in counties with lower literacy. Assuming that the impact of Japanese colonists on literacy was minimal (in most counties they were 1-3% of the population), this suggests convergence in literacy throughout the peninsula as the younger generation made up a larger proportion of the literate population in counties on the lower level.

Literacy rates for 213 counties in 1930 were tabulated in whole and by sex[58]. Maps I, II, and III depict the rates on the provincial level for the combined rate as well as for men and women, respectively. On the provincial level, Heian Nan (38.99%) and Heian Hoku (35.89%), corresponding to present-day

[56]209/213 counties were matched.

[57]One county, Yangju, in Keiki, had a higher total literacy rate. Five counties, Kilju, Shirotsu, Funei, and Mosan in in North Kankyo, as well as Yangju, had a higher female literacy rate.

[58]While the 1930 census divided the country into 234 districts, the agricultural survey which focused only on rural areas, recorded data on 220 rural counties. Ultimately because of name changes and redistricting, 213 counties were matched from the census and agricultural survey. Urban areas, including Seoul, Incheon, Pusan, and Mukpo are therefore excluded from this analysis. Urbanization occurred during the late Joseon when 3% of the population lived in urban areas, and extended into the colonial era such that by 1940 11.6% of the population was located in urban areas.

South Pyongan and North Pyongan & Chagang provinces in North Korea, respectively, had the highest total literacy rates. These were followed by Kokai (34.15%, present-day North & South Hwangae), Keiki (33.76%, Kyonggi), and Kankyo Haku (32.79%, North Hamgyong). The least literate were Keisho Hoku (22.42%) and Keisho Nan (23.01%), corresponding to present-day North Gyeongsang and South Gyeongsang provinces in South Korea respectively, Chusei Hoku (26.25%, North Chungcheong), Zenra Nan (26.91%, South Jeolla), and Kogen (27.14%, presently divided between Gangwon in South Korea & Kangwon in North Korea). Of the top 10% most literate counties, 8 were in Heian Nan, 5 each were in Heian Haku and Keiki, 2 were in Kokai, and one was in Kogen. The combined literacy data appeared normally distributed, but by conducting a shapiro-wilk test it was revealed to not be normally distributed at a 95% confidence level. The distribution itself however is approximately symmetrical (skewness of 0.306).This contrasts with data for female literacy which was neither normally distributed nor symmetrical, but moderately right-skewed with a skewness parameter of 0.637. Male literacy was the most symmetrical with a skewness parameter of 0.264. The mean county literacy rate was 29.67%. It's notable that out of the five most literate provinces, all outside of Keiki (the province containing the capital) were located in the northern half of the country.

There was a clear spatial divide in literacy rates between sexes. In some counties up to 3/4 of men were literate and almost nowhere were less than 1/3 of men in this category. Yet female literacy, outside of one county (Gimpo, 24%) near the capital, was never more than 1/5 and dipped as low as 2% in some areas. The mean male literacy rate was 49.94% and the mean female rate was 8.68%. This is similar to the Qing-era Chinese literacy rates observed by Westad. Surprisingly, there did not seem to be a correlation between male and female literacy rates. While male literacy followed a similar geographic distribution as total literacy, being concentrated in the northern half of the country, female literacy did not. Instead, the provinces with the highest rates bunched along the southwestern coast of the country. One county in Heian Nan had a male literacy rate of 73% and a paltry female literacy rate of 5%. Thus, it seems likely that different factors affect female and male literacy rates. A factor that could be contributing to this effect is that in every province literate women under 15 years of age made up a much higher proportion of their respective population than did men and thus a higher proportion were excluded from these figures. In fact, the provinces with the lowest female literacy rates, Kankyō Nan (4.2%) and Kankyō Hoku (5.56%) also had the highest percentage of literate women between the ages of 6-14 at 36.7% and 35% respectively. That is, of all literate women in Kankyo Nan, 36.7% of ten were between the ages of 6-14.

3.2 Labor Intensity

A labor intensive path of growth was previously defined as the process where increasing labor inputs, rather than increasing land or capital, are the source of rising production. The path is characterized by an abundance of labor, which decreases its relative factor price and allows it to develop as the focal productive factor. Meanwhile, capital inputs are scarce and have a high opportunity cost. Land inputs are also heavily constrained since the marginal cost of opening new land rapidly rises as land increasingly closer to the agricultural frontier must be developed. In order to better understand the drivers of growth in a labor intensive economy, consider the following modified Cobb-Douglas production function:

$$Y = A\,\bar{C}\,f(T^{\gamma}\,K^{\beta}\,L^{\alpha})\,, \tag{1}$$

where A is total factor productivity, C is a constant of climate and topographical (i.e. environmental) conditions, T are land inputs, K are capital inputs, and L are labor inputs. α, β and γ are the output elasticities of labor, capital, and land, respectively. Total factor productivity (TFP) refers to new techniques and technologies for increasing output with the same level of factor inputs. Since environmental conditions are given as constant and it was previously stated that land and capital are scarce, most of the increase in yields in seems must come from shifts in labor or total factor productivity. An additional avenue through which yields can be increased however is through changes in output elasticity, especially that of labor (β). An example of this is the creation of new fertilizers or inter-cropping methods which tend to be labor absorbing. These techniques increase the amount of labor that can be employed with given land and capital inputs by reducing the decline in marginal labor productivity caused by an increase in labor. This is the ”technical hairsplitting” that was mentioned by Goldenweiser (1936) and elaborated by Geertz (1963) as part of his work on agricultural involution in Indonesia. One way, for instance, to increase rice yields is to drain paddy area during the off season and plant it with soy beans and other nitrogen enriching crops.

This requires greater labor inputs to the point where most of the increase in yields that come as a result of this method are overshadowed such that average labor productivity remains constant. However, they allow for a greater population to be employed in productive agricultural work. Geertz described these changes as ”an effort to provide everyone with some niche, however small, in the over-all system.”

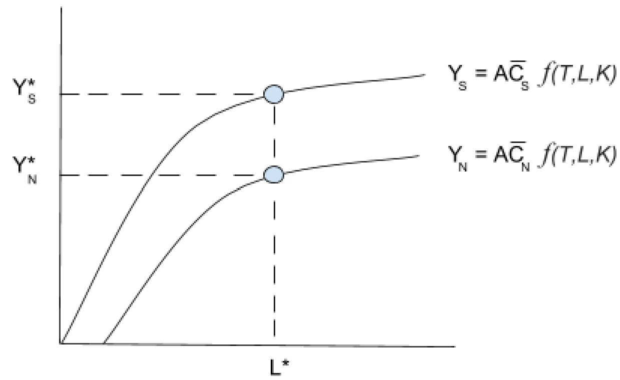
Measures of agricultural variables were taken from an agricultural survey conducted by the Japanese government in 1933 and 1938. The purpose of the survey was to investigate the effects of a five-year plan initiated in 1933 which sought to reorganize the peasant economy. The survey covered 220 counties and surveyed 1919 households in total, of which 1859 completed the survey. The data was used to construct four measures of agricultural intensity: (1) labor inputs, (2) output elasticity of labor, (3) land use, and (4) land productivity.

3.2.1 Measure 1 — Labor Inputs

The first and most direct measure for labor intensity used in this study are labor inputs; specifically the number of households cultivating a hectare of land, including measures for total land, paddy land, and area used for rice cultivation. An important note is that although factor inputs are usually analyzed for their effect on output, it is not a focus of this study if and to what extent factor inputs increase yields. Their concentration in production is evidence enough for a labor-intensive growth path. It is not the case that higher yields are the product of higher labor inputs. Consider the following modeled growth paths:

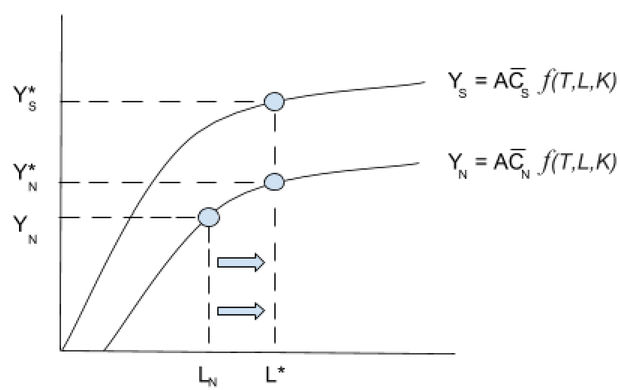
The figure depicts two possible growth trajectories for representative counties in the northern and southern parts of the peninsula. The cause of their divergence are environmental factors that make it much more difficult to increase agricultural output in the north than in the south. Therefore, though they are both examples of labor intensive economies with comparable inputs of labor, their corresponding outputs

Figure III: Two Growth Trajectories



and levels of labor productivity differ. Increasing labor certainly does still increase outputs, but the effect may be much less than that of other effects that are completely outside the production process. Instead of measuring output or labor productivity, observing labor inputs into the production process is perhaps the most direct way to measure for agricultural intensity. However additional effects that impact labor inputs need to be controlled for. Consider the following movement along the production function:

Figure IV: A Shift in Labor Intensity



Northern county N used to produce Y_N output with L_N units of labor. However, in this case a nearby factory was constructed and as a result intermediary agricultural goods became much cheaper. With the same amount of inputs, county N is able to increase their level of labor inputs to L* and move along their production function. However, if labor inputs are used as the measure for labor intensity, such effects should be controlled for in order to model only the decision to increase inputs. This also means controlling for temperature that is likely affecting labor in the southern county. A set of controls is suggested in subsequent sections.

Total labor inputs, that is into both paddy and non-paddy land, ranged from 1.74 households per hectare[59] in Gyeongsan County, North Gyeongsang province (0.57 hectares per household) to 0.148 households per hectare in Huchang in North Pyeongan province (6.76 hectares per household)[60]. The variable was not normally distributed, but had a distribution that appeared to be more exponential. The arithmetic mean was 0.626 and the geometric mean was 0.553 households per hectare. Average land holding in the south was much lower, 1.25 hectares per household, [61] than in the north where it was 2.91 hectares. As expected, the further one travelled north the larger farm sizes one encountered (see map 2.1 for details). Labor inputs into paddy and land cultivated with rice didn't vary much between each other; paddy land exceeded cultivated area by an average of a bit over 1%[62]. About half of the observations for labor inputs into paddy land ranged from 1 to 2 households per paddy (0.5 to 1 hectare of paddy per household). The distribution displayed an even more exponential behavior that that for total land: one county in North Pyeongan reported 21.92 households per hectare (0.46 hectares per household) of paddy. This seems to be not an example of labor intensity so much as environmental factors preventing the spread of rice cultivation (see map 2.2 for details). The county had a relatively normal labor input of 0.247 households per acre of total land. Though these northern counties exhibited higher labor inputs in paddy land, it is important to reiterate that this does not mean that they experience the most labor intensity. For that to be argued, additional effects have to be controlled for.

[59]This study assumes that differences in household composition are random, or at least not related to the extent of labor intensity.

[60]Both labor input and average land holding/farm size are reported here since they are inverses of one another.

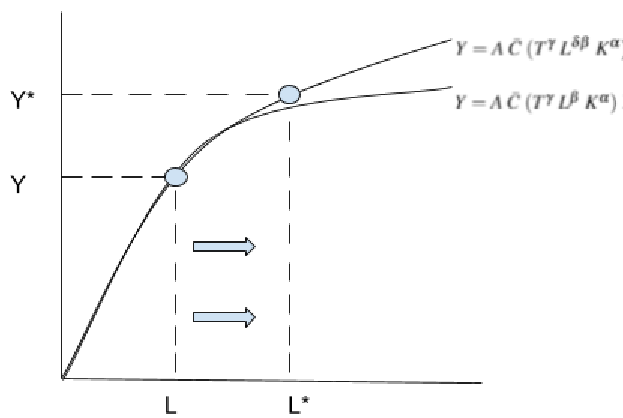
[61]Bray reported that household land holdings in the south in the post-war were generally under a hectare in size. The data used in this study generally reflects this trend, especially in light of post-war land reform.

[62]About half of areas in fact had more area used for rice cultivation than paddy. This was presumed to mean that upland rice was being cultivated and not disaggregated from wetland rice values. Interestingly, there were many such cases in the southern rice basket suggesting that a land frontier in rice had already been reached since labor was put into lower yielding varieties.

3.2.2 Measure 2 — Output Elasticity

The second measure employed to explore labor intensive growth is the density of fertilizer application, looking at both a traditional "self-produced" type and a modern fertilizer commonly purchased on the market[63]. An increase in fertilizer application is a common example of a labor-absorbing input. Yet it's neither an input of labor since it cannot produce anything on its own nor is it a capital input since it's an intermediary good used up in the production process. Moreover, it does not represent a shift in TFP which is understood as knowledge devoid of physical inputs. While an increase in TFP would generally result in a symmetric shift of the production curve upward, this change in the output elasticity impacts the shape of the curve. Consider the following case:

Figure V: A Shift in Output Elasticity



Movement along the production function begins with an increase in labor from L to L*. The resulting need to employ this surplus incentivizes the introduction of labor-absorbing inputs (represented by δ, $\delta > 1$), affecting the output elasticity of labor. Labor's output elasticity grows from β to $\delta\beta$ [64]. Production then increases from Y to Y*. This is similar to a change in TFP since the curve partially moves outward.

[63] The former was reported in weight produced while the latter in yen spent, which prevents the two measures from being combined.

[64] An output elasticity of 1 signifies constant marginal returns, while one greater than 1 represents increasing marginal returns. Per the law of diminishing marginal returns, $\delta\beta < 1$.

However, it moves out more relative to the amount of labor inputed into production and for this reason needs to be differentiated from TFP change.

Maps 2.3 & 2.4 depict the spacial distribution of these fertilizers which differed significantly in quality and usage. Purchased fertilizer averaged around 678 yen per km^2, with the highest being 4,086 yen in Gimje on the coast of North Jeolla, and the lowest being in 18 counties spread mostly between Hamgyong and Pyeongan where it was reported that no fertilizer was purchased. This finding was one of the main reasons why homemade fertilizer, referred to as compost, was added as an additional proxy for fertilizer usage. It's likely that fertilizer was used, but it was acquired outside of the market. In fact, the average expenditure of 678 yen per km^2 , or about 11.7 yen per household, was also surprisingly low[65]. Compost on the other hand averaged 9,482 kg per household, or about 0.56 kg per m^2. This seemed like an excessive amount of compost to produce within a year, even counting the tendency of large households. It may be that a large portion of this compost is originating from agricultural activities. All counties produced at least some compost. The highest by far was at Pyŏktong in North Pyeongan ($8.45 kg/m^2$). This seems to be an extreme outlier; the next closest to it was Namwon in North Jeolla at $1.77 kg/m^2$ (9,916.17 pounds per household), which seemed much more reasonable.

The distribution of fertilizer usage was heavily concentrated in the southern half of the peninsula. North Jeolla had the highest average county value, which may also reflect its high land productivity discussed later. The distribution of compost production was similarly centered on the south. However, North Pyeongan surprisingly had the highest average county value. This is a result of Pyŏktong's outlier influence and most likely should be discounted. None of provinces bordering it reflect this trend. Nevertheless, this may explain part of the story of why North Pyeongan does reasonably well in land productivity measures. Neither of the measures were normally distributed. Fertilizer displayed an exponential distribution

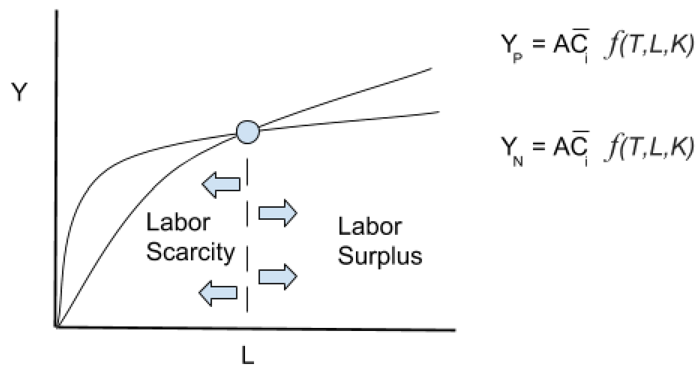
[65]With household income averaging around 260 yen, this seemed like a very low sum as the principal capital input in agriculture

while compost was left skewed.

3.2.3 Measure 3 — Land Use Ratio

The third method used to identify labor intensity was the land use ratio, or the ratio of land cultivated with paddy over total cultivated land. Consider the following two household production functions:

Figure VI: Rice is Labor Absorbing



Household P's only inputs of land are in the form of paddy and therefore they must only produce rice, while household N doesn't have any paddy land inputs and hence does not produce any rice (but instead grows other dry grains such as wheat and legumes, including soybeans). Both households have the same environmental constraints i. When labor is scarce, both households will have to substitute land and capital for labor. This is advantageous to household N since their production responds well to land and capital inputs. Relatively cheaper land ensures greater benefits from developing complex crop rotation systems. It also means that production falls much less if fields remain fallow during the off season. Meanwhile, household P's production is low since there is not enough labor to take on the crucial tasks of transplanting and weeding. Capital exists in the form of tools that can make those jobs easier, but those tools themselves require large amounts of labor to take advantage of. By moving from a labor scarce economy to one with a surplus in labor, household P's production function allows it to increase output above that of household N. This is because rice has a much higher output elasticity of labor than do comparative dry cereals. When a labor surplus emerges, it becomes advantageous for household N to mirror household P's function by transferring their labor from non-paddy to paddy land. Hence, by noting the ratio of labor put into rice cultivation as opposed to that put towards non-paddy crops, an index of labor intensity can be established.

A particular strength of this method is that it provides a measure that displays more stability over time than do fertilizer inputs which can vary greatly year to year. Observe the decision of household N to convert production from non-paddy to paddy in response to a labor surplus. Labor moves to where its marginal unit is most productive until all options procure equal yields such that:

$$\pi(\frac{\delta y}{\delta L_P}) = (\frac{\delta y}{\delta L_N}) \ , \tag{2}$$

where π is the relative price of the outputs, L_p is paddy land and L_N is non-paddy land. Equilibrium is reached when the marginal output with respect to a marginal unit of labor in paddy land, $\frac{\delta y}{\delta L_P}$, is equal to the alternative (i.e. opportunity cost) of investing labor into non-paddy land. Therefore, relative productivities and the relative prices of each type of crop determine the level of intensity. The marginal productivity for each type of labor is a function such that:

$$\frac{\delta y}{\delta L_P} = f(A_p, C_p, T_p, L_p, K_p) \tag{3}$$

$$\frac{\delta y}{\delta L_N} = f(A_N, C_N, T_N, L_N, K_N) \tag{4}$$

$$T = T_p + T_N, \qquad L = L_p + L_N, \qquad K = K_p + K_N \tag{5}$$

Environmental effects will impact each type of crop differently while TFP will vary depending on the techniques and technologies used for each type of crop. Land, labor, and capital must then be distributed between these two competing interests. Whereas capital and labor can somewhat easily shift to respond to market and technology changes, shifting land is the most difficult process since the land itself must be converted to paddy in order to grow high yielding wetland rice. Changes in labor and capital inputs hence are constricted by the amount of land that has been converted to paddy. Since the amount of labor put into rice cultivation can vary significantly (especially in different parts of the season), the land use ratio, or the ratio of land that has been converted to paddy is a more long-term indicator of labor intensity in agriculture.

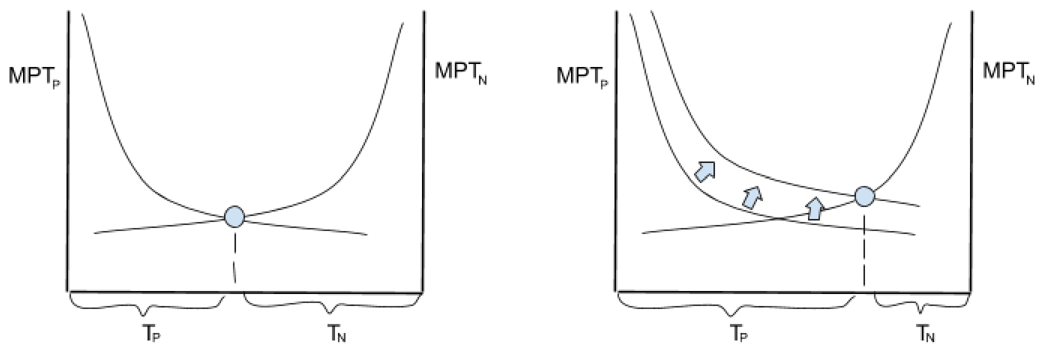
One issue in such a measurement is that it may pick up extensive rather than intensive growth. Extensive growth is when increases in production are primarily due to increasing inputs of land. A classic example of an extensive path of growth comes from Habakkuk (1962) who argued that land abundance on the American continent coupled with relative labor scarcity encouraged the pursuit of labor-saving strategies. A similar pattern of growth has been argued to have transpired in other sparsely populated areas including southeast Asia. When labor supply increases, households generally have two choices on how to best employ this labor. If labor is comparatively more scarce than land, then households will prefer to bring new land under the plow and pursue technologies such as more advanced ploughs which allow them to till greater areas. If land is comparably more scarce than labor, then households will prefer to intensify their fields by converting them (in the Asian case) to paddy. If they select the former and turn this new land into paddy, they will be increasing their land use ratio, but growth will still exhibit the characteristics of extensiveness. As a result, the need for ”technical hairsplitting” will fall as increases in population will simply be absorbed through increasing the amount of cultivated land. The land use ratio hence must be reinterpreted to only consider the effects of the latter option where already cultivated land is transformed into paddy. By holding constant for the average household farm size one can explicitly test for the effect of land conversion rather than expansion.

Just as it did for labor, the distribution of land type depends on marginal productivities and relative good prices such that:

$$\pi(\frac{\delta y}{\delta T_P}) = (\frac{\delta y}{\delta T_N}) \qquad (6)$$

That is, equilibrium is reached when the marginal output with respect to paddy land, $\frac{\delta y}{\delta T_P}$, is equal to the alternative (i.e. opportunity cost) of investing resources into non-paddy land, T_N, with the relative prices of the outputs, π, accounted for.

Figure VII: Relative Marginal Productivity of Land



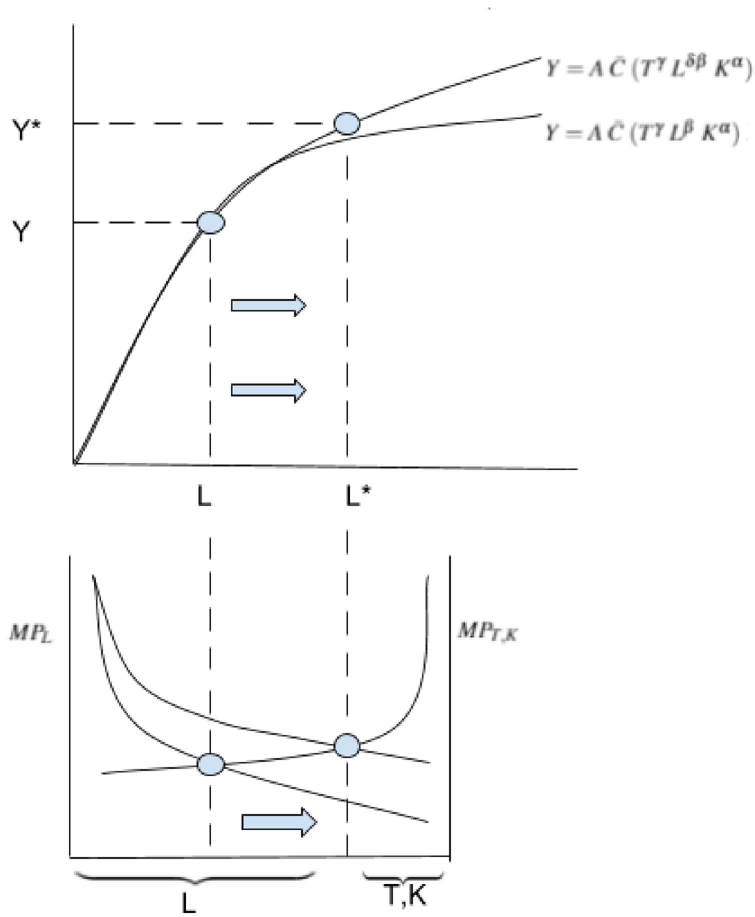
Assuming that productivity has already been adjusted by relative prices, Figure VII depicts how the land use ratio is determined and illustrates a shift in this distribution. In the first diagram the intersection of the marginal labor productivity of paddy and non-paddy land determines the percentage of the total cultivated land that they make up. In the latter diagram, an exogeneous event that precipitates the fragmentation of land into small owner-cultivator plots engenders a tenancy system which encourages risky investment into new types of fertilizers. The result is an increase in proportion due to an exogeneous effect. Since the goal is to simply measure the results of the decision to intensify, a set of control variables which would account for such forces need to found in order to isolate the effect of labor intensification.

Map 2.5 depicts the provincial distribution of paddy land as a percentage of total cultivated land. The land use ratio averaged 43.83%, with the most paddy located in Gunsan on the western coast of North Jeolla (89.24%) with no paddy at all in the neighboring counties of Kyongwon and Musan on the border with China in North Hamgyong. Upland rice however was harvested in Kyongwon. The distribution was not normal, but appeared to be more uniform with a congregation of values near the median. Looking at the map, the distribution follows the expected spatial pattern: generally moving north reduces the value. Provinces bordering the eastern coast also have less paddy, reflecting their mountainous topography. Although there was no surprise that North Hamgyong had one of the lowest values, the fact that the more southern South Pyeongan was also very low, instead of North Pyeongan or South Hamgyong, was surprising.

3.2.4 Measure 4 — Land Productivity

Finally, land productivity serves as the fourth and final measure of the development of labor intensity. Consider this extension to the model introduced when discussing shifts in output elasticities:

Figure VIII: Factor Productivity



The process commences just like it did in measure 1 with an increase in labor from L to L*. The result as it's been shown will be an increase in the output elasticity of labor. However, this affects not only the marginal productivity of labor, but also that of land and capital. The second model depict the increase in labor as a result of the growth in output elasticity in terms of the trade off between factors. All three types of factors are required in the production process, but depending on their relative cost producers can substitute more expensive factors for less expensive ones. They do so up until the marginal productivity of each unit (normalized for price) is equal. When the output elasticity of labor rises, more labor is substituted for the other factors such that only the most productive factors of land and capital are utilized. Hence, marginal land and capital productivity rises. Interestingly, marginal labor productivity rises as to meet it as well. This makes sense since although an increase in output elasticity is not an increase in TFP, but at high inputs of labor it behaves like one. The rise in output elasticity, allows marginal labor productivity to decline slower, giving it a higher value at a given input level.

This observation allows labor intensity to also be measured in terms of factor productivity (when controlled for other variables). Though marginal factor productivity is difficult to account for, average factor productivity can be used as a substitute with only a few caveats. Namely, average productivity will be influenced by high values of the most productive factors which do not accurately represent the factor trade offs experienced by producers. A rapid fall in marginal productivity will take longer to become evident when using average rates. Expressing differences in average productivity in terms of natural logs would make analysis more sensitive towards such shifts.

Map 2.6 presents the distribution of land productivity in rice within the peninsula[66]. Land productivity averaged around 28.73 koku per chō[67] on the county level, ranging from the highest in Gunwi in

[66]Both paddy and upland

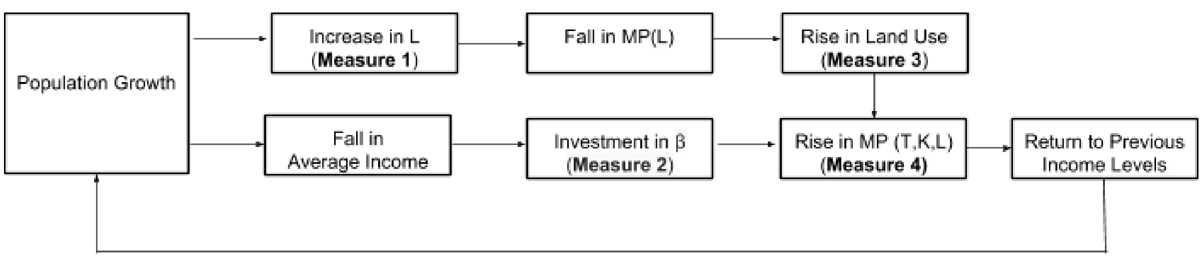
[67]Though initially reported as to (斗) per se (畝), these were converted into the more commonly used koku (石) and chō (町) measurements. A koku was redefined in 1891 as approximately 180 liters. A chō came to just under a hectare. Unfortunately, comparisons to modern rice yields are impractical since those are most commonly reported as tons per hectare, while no measurement of mass was provided by the survey. While estimates say that a koku weighted around 100 kilograms, this could

North Gyeongsang (45.96) to the lowest at 0 in Musan where it was previously stated that neither paddy nor upland rice was grown. The data was not normally distributed, but left-skewed. There was some overlap between the most productive provinces and those with the highest land use ratio in Jeolla, however the North-South divide wasn't as dramatic than it was in the land ratio. In fact, Hwanghae and North Pyeongan were as productive as some of the southern provinces which grew more rice.

3.2.5 An Integrated View

An additional way to look at these four measures of labor intensity is to see them as different components of the same process. Figure IX presents an integrated view into the relation between them.

Figure IX



The framework follows Boserup's (1965) theory that population growth fuels the process of productivity growth and adapts it to the Korean context. Population growth is what initially pushes production out of equilibrium. Assuming that population growth is continuously occurring[68], there are two constant forces acting upon labor: decreases in average income simply because the same income now has to be divided among more individuals, and decreases in the marginal productivity of labor (i.e. wage) as a result of a constant increase in the labor force. As Boserup argues, productivity growth in the pre-industrial era occurred because of pressures to preserve existing income levels. Hence, while population growth brings

vary significantly based on cultivation methods and thus was judged not reliable enough to be reported.

[68]This had been the case in Korea since the 14th century outside of declines in the aftermath of the Japanese invasions in the late 16th century and a smaller decline in the late 18th century.

these depressing pressures on incomes, over time it stimulates investment in skill and technology in the struggle to preserve income levels. In the case of labor-intensive economies, this investment is focused on labor-absorbing inputs that raise the output elasticity of labor. As it's been show, these changes affect the land use ratio and stimulate an increase in TFP. The result is a return to previous income and wage level. The cycle repeats when the new higher carrying capacity of land encourages further population expansion.

3.3 Climate

An important issue that hasn't been addressed yet are geographic constraints to agriculture. While this study investigates the effects of agricultural intensification, one would expect the processes of intensification to manifest differently based on the environment. This has already been seen in the comparison between intensive rice cultivation in Korea and Japan, which have more climatic and land constraints imposed upon them, and extensive growth in southeast Asia, which with its long summers and wet seasons is an ideal place to grow rice. Such dynamics repeat themselves on the Korean Peninsula. The northern part has a much shorter and cooler summer in addition to having less rainfall than regions in the south. Analogous to the example on the macro-level, one would expect more intensive cultivation in the northern part of the country. However, this may not be the case. The peninsula is already not ideal for rice culture; the less ideal parts of the region border on being physically unable to sustain a permanent rice crop. Hence, what might be an average value for land productivity and land use ratio in some areas can be a sign of intensification in others. Thus, the model should control for these climatic and physical factors to find where the process of intensification is most advanced. Skill building, labor pooling, and diversification of economic activities are likely to occur sooner in areas less adapted to rice cultivation because of resource constraints, to a certain point. Specifically, we expect that proportion of land used to grow rice will increase as the climate becomes favorable, while average land productivity will gradually fall as it approaches southeast Asian levels. However, in regions beyond a certain threshold we would expect both to fall.

We therefore control for crucial two climatic variables affecting rice cultivation: temperature and precipitation. Elevation and slope were briefly considered as additional control variables, however, difficulties with overlaying the topographical data with the counties defined in the 1930 census prevented evaluation of the majority of counties. Specifically, slope (i.e. the percent of land with a slope of less than 12° , was calculated for 35 counties[69]. For temperature, we use two different datasets. The first comes from Willmott & Matsuura at the University of Delaware (UDEL)[70] which provides a mean air temperature averaged by month from 1900-2014. The second set comes from the National Center for Atmospheric Research (NCAR) and provides a mean air temperature for September 1930. Each of these sets has their own strengths in this study: the UDEL study has more reference points and thus has more precise estimates. Viewing temperatures throughout the year controls for their effects on agricultural activities in different seasons, while averaging by month allows for discounting of extreme short-term weather events. With this however, regions which vary widely in temperature in different times of the year will lose their variability when being averaged. Meanwhile, the NCAR dataset focuses on one month, September 1930[71]. This particular month was chosen to coincide with the typical end of the rice growing season. Changes in temperatures here, say warmer weather, may have marginal effects on whether a second crop is harvested and how much effort is put into it. However, using September from this single year might also unbalance the analysis. Both sets were initially interpolated by researchers. This study then did an additional interpolation to produce measurements for all land area. For precipitation, we use data gathered by Fick &

[69] Slope data comes from the Japan Aerospace Exploration Agency (JAXA) ALOS Global Digital Surface Model, which publishes data on a 30 meter mesh.

[70] UDel$_{A}irT_{P}recipdataprovidedbytheNOAA/OAR/ESRLPSD,Boulder,Colorado,USA,fromtheirWebsiteathttps : //www.esrl.noaa.gov/psd/$

[71] NCAR community. June 2004. Community Climate System Model, version 3.0. http://www.cesm.ucar.edu/models/ccsm3.0/ NCAR/UCAR. GIS data services are provided by NCAR .

Hijmans at the University of California, Davis[72]. We use data on mean total rainfall in September from 1970-2000. One county, the island of Ulleung, had to be dropped for lack of precipitation data.

As mentioned in the discussion on elevation and slope, there were difficulties overlaying county data as a result of changes in boundaries. As a result, temperature and precipitation data was derived by locating data at the center of the county. A future more rigorous study should look to average temperatures over the county boundary. Map 2.1 displays the temperature distribution over the peninsula from the UDEL study. It's immediately striking how low these temperatures are; virtually all counties have an average temperature below 0° C with the average at -7.3° C. An initial concern therefore was that the data was off somehow. However, the strong correlation between the UDEL and NCAR measures suggest that, at least within the UDEL set, temperature data is, if not accurate, at least precise. One possibility is that this is caused by bad historical data collection. Tongyeong had the highest temperature at 0.29° C, while Samsu county had the lowest at -22.16° C. As most climate data, the variable is not normal (P ¡ 0.001 for Shapiro-Wilk), but is left-skewed with a few very low temperatures. Since the majority are negative values, a log transformation is impractical.

The distribution of temperatures otherwise looks like what one would expect: as one move further north one encounters increasingly cooler temperatures. The rapid temperature decrease in the south-central region is resolved by the fact that this is a particularly mountainous region away from warm ocean currents. Warm currants seem to have a particular impact in the Northeast where a small band of warm temperatures along the coast is quickly overtaken by colder temperatures stemming from winds from the northern mountain ranges and the Manchurian plain. There are some strange temperature anomalies off this coast, a result of heavy interpolation, but they do not impact county-level data. Warm currents also seem to have an effect on the Southwest coast where relatively warm temperatures extend as far north as

[72]Fick, S.E. and R.J. Hijmans, 2017. Worldclim 2: New 1-km spatial resolution climate surfaces for global land areas. International Journal of Climatology.

Keiki. However, they don't seem to have much of an effect on the East coast around Kogen probably as a result of the cool air from the Taebaek mountain range.

Though the NCAR observations were also not normally distributed, spatially they created smoother transitions (see map 2.2). This is somewhat unexpected since we predicted that a distribution from a specific month would be much more varied than that averaged over a century. The slight decrease in reference points may play a role here. Temperatures were much warmer than those from UDEL and reflect what would be generally expected during the early fall. The average temperature was 17.6° C and ranged from 22.35° C in Wando to 11.81° C in Chasong. Logging the temperature here is possible. We run the regression both logged and unlogged to see whether this impacts our results.

The main difference was that spatially the coasts were much less significant in inducing temperature variance. Temperatures were still comparably cooler compared to inland points on the same latitude, but less significantly so. The difference is particularly visible on the Northeast coast where temperature falls a degree or so compared to around 10 degrees in the UDEL data. The Taebaek mountains seemed to produce no temperature effects; only did the mountains in the north cause substantially lower temperatures.

The temperature data was also very skewed, appearing to have more of a bimodal distribution than normal. Therefore, we also run a regression with the values logged-transformed. The average precipitation was 135.89 mm, with values ranging between 200 mm in Gangneung to just 77 mm in Samsu. The southern and eastern coasts of the peninsula received the most rainfall, while going further inland and north decreased precipitation. The northeastern coastline was in a higher band that other location further inland. The least rain was up in the northern mountains where a large proportion of the precipitation would fall as snow.

3.4 Additional Controls

Other variables this model controls for are are average size of household paddy land holdings, household income, land ownership rates, manufacturing employment rates, and whether a county would be located in North or South Korea in the partition after the war. As discussed previously, by controlling for the average size of household paddy land, it is possible to use the land use ratio to proxy for intensive rice cultivation. While normally a high land use ratio would mask whether growth were intensive or extensive because a large input of land could wash out any otherwise increases in productivity provided by converting from the alternative dry grain crop. By controlling for household paddy size, a higher proportion would indicate intensive small scale agriculture. The largest areas of paddy land per household were found in Sukch'ŏn county in Heian Nan (26,517 m2, or about 6.5 acres). That's a large area, but it makes sense that it would be located in the northern province where land was much cheaper and land ownership generally prevailed over tenancy systems. Outside of the two already mentioned counties without any paddy, it's surprising to that the county with the smallest paddy per household size is Nyŏngwŏn county, also in Heian Nan (456.2 m2). The average was around 8,000 m2, or just under two acres. The average total holding was around 20,000 m2 . This is a larger area than Bray's findings from the immediate post-war where the majority of holdings were under a hectare (10,000 m2), however those statistics were only for South Korea. With the north excluded, the average landholding in 1933 drops to just under 14,000 m2. Spatially, the largest paddy plots were concentrated along the eastern and southern coasts (map 5.1). However, the overall largest household farm plots increased as one traveled further north (map 5.2). While climate had a large effect in reducing the amount of rice that could be planted, it also meant that larger amounts of land had to be cultivated to sustain the population.

An additional factor in this distribution may be land ownership, which concentrated on the north and east coast (map 5.3). Owning one own's land made an added incentive to intensify cultivation not only because increasing yields would not result in higher taxes (unlike rents for tenant cultivators), but also because they had added security that the land would not be taken away from them. This security in investments may have also induced landowners to make longer term plans by investing into skills and education. Land ownership is generally associated with larger household plot sizes, although the continued existence of the small landowner is a mark of the intensive rice economy. Though values ranged greatly (from 11%-96%), the variable was one of the only ones in this study which exhibited a normal distribution. The average centered around 49.58%. Certainly there was polarization in the countryside as the proportion of landless tenants grew from 44%-53% between 1926 and 1932[73]. However, the instance of absentee owners appeared low.

Household income was an additional variable that needed to be taken into consideration as a confounding variable. A higher income offers both more opportunities to invest in education and greater access to expensive capital inputs to agriculture. The highest incomes were on the west coast of the peninsula, interestingly almost mirroring land ownership rates. The lowest incomes were generally in N. and S. Gyeongsang which bordered on some of the richest provinces. The average household income was 258.73 yen[74] . The distribution of incomes appeared exponential and as the effects of income commonly decrease as incomes grow, the natural log of the variable was used.

The manufacturing data was compiled by Jean & Paik (2017) and looks at the number of people working in manufacturing in 1909. This variable was normalized to a rate of workers per 10,000 inhabitants. The data was heavily right skewed where a few counties centered on industrial areas such as Tongyeong, Gimhae, and Nampo, which were not excluded, unlike other moe urban areas, from the agri-

[73] Shin

[74] The Angus Maddison Project (2018) gives the gdp per capita in the area which would become South Korea in 1936 as $1,135 (2011USD$). The average household income for the same area from survey data is 248.46 yen. Professor Rodney Edvinsson's historical currency conversion tool gives the 248.46 yen approximation in 1936 as $1,254.43 (2011USD$). However, these are supposed to be household measurements while the Maddison data is per capita. Household size was larger than it is now. One possibility is that the survey data doesn't include all production by cultivators, but only that which was sold on the market.

cultural survey. Proximity to manufacturing may entail greater access to capital inputs into the production process as well as greater access to human capital since manufacturing would attract more innovative and entrepreneurial workers. It could also impact household income by providing a greater market for goods, and then influencing the ability to intensify production.

3.4.1 South Dummy

The study also introduces a special dummy variable for whether a county would become part of South Korea after the partition at the conclusion of the Korean war. The division between the north and south is a staple source for political scientists and economists of how political institutions can radically alter development trajectories [75]. Though the split was certainly historical accident based on the timing of the Soviet invasion, the idea that the northern and southern portion of the peninsula had been homogeneous up to that point needs to be reexamined. By using this dummy variable, this study argues that the post-war political division was roughly representative of differences in economic dynamics had caused a divergence centuries previously between the regions. Unlike in analyzing political institutions, the border here cannot be used as a sharp division of pre-war economic dynamics. However, the effects of border counties on each side should balance each other out. This dummy also allows for an analysis of whether environmental factors affected labor intensity, or whether institutional differences between north and south played a greater role. By controlling for the dummy, one can check how strong the effects of weather were within each region.

William Baird, one of the earliest westerners missionaries to enter this area, noted that the social makeup of the north differed substantially from the rest of the country. The traditional Korean aristocratic class, the yangban, was almost wholly absent from the region. There were families who had risen to

[75] Acemoglu & Johnson

prominence, but few could claim the long distinguished heritage of the southern elite. Yi Kwangnin's research, in part inspired by Baird's observations, argued that the absence of such an elite allowed for a mercantilistic middle class to develop here further than anywhere else. Proper yangban did not engage in trade and placed disdain on such activity. Their absence allowed Pyeongyang and other northern cities develop as trading hubs between Korea and China, especially since wet rice cultivation proved be to be not a sustainable source of income. Often treated as outsiders, northern merchants and educated elites were frequently denied advancement in the political bureaucracy. The opening of schools by western missionaries therefore gave them an opportunity to bypass what many saw as oppression by the southern elite and gain an advantage through western education. This may have been one of the reasons why missionaries saw their greatest advancement in this region. Clark cites isolation from the political center and a sense of discrimination, as well the reliance on economic activity outside of agriculture, commercial traffic in the region, and geography as the main reasons as to why missionary efforts were so much more successful there. Moon Hwang traces these particular characteristics of the north through the region's distinctive history. The north had for centuries been a no man's land outside the control of the Korean monarchy. Marauding tribes of Jurchen, Mongols, and Manchu would exploit this to conduct raids further south. When the construction of fortresses along the border proved ineffective, it was decided that mass resettlement of Koreans into this vacuum would be the best way to maintain order. The resettlement, or samin policy, began in the 15th century by moving those those who had already been living in the border provinces further north. Some incentives for movement were first offered, but citing the lack of volunteers, the government began to mandate resettlement. Such a requirement was waived for yangban families, many of who began to relocate themselves to the capital to distance themselves from the stigma of being associated with the north. In their place "bands of soldiers, hereditary clerks, government slaves, and criminals" were moved to the northern frontier.

This may have introduced a sense of social dynamism in the region. Red peasant groups were primarily based on the northeastern provinces and their activities often led to violent clashes with Japanese authorities. In those regions colonial authorities were confronted on issues ranging from taxes to interference in local village structure. These red peasant groups would often set up night schools which in addition to distributing communist and anti-imperialist literature, provided literacy education. These would often be raided by Japanese authorities in what would sometimes become violent clashes. This was one reason why Japanese administrators preferred assignment to the southern provinces. To encourage administrators to take up posts in the region, an additional resettlement stipend was issued. However, it was only with the growth of industrial activity in the 1930's as well the extension of the railroad and strengthening of the police presence that brought Japanese colonists to the area.

For this reason it was considered that using a south dummy would be effective in drawing out regional and institutional dynamics that are otherwise difficult to evaluate. For one, the components of the demand for education may differ greatly from the two regions. Education in the south was conceived as studying the Confucian classics in order to enter the political elite and not as a method of increasing one's financial standing per se. In the north, entrance into the political elite was almost impossible. The strong response to missionary educational investments then must have come from some other goal. Education in western sciences may have been considered as a method to increase one's earning potential. Learning foreign languages also allowed one to engage in trade relations with foreign merchants that were making their increasing presence known.

3.5 Checks and Relations

Several checks were performed to test for the robustness of different variables and understand the strength of their effects on the model. First, the relationship between climate and agricultural intensification was explored. The hypothesis was that there would be little to no relation between them. Though climates more supportive of rice cultivation encourage the diffusion of the crop, rice itself follows a less intensive growth track since there is little incentive to intensify. However, this does not mean that more harsh climates will support more intensive growth since rice will simply be unable to take root. With the peninsula's great diversity of climate one would expect the two trends to cancel each other out. Hence, while the three climate variables were significant and positively correlated with the land use ratio (explaining more than 50% of its variance), their ability to do so with land productivity was minimal with precipitation being completely insignificant, UDEL marginally insignificant, and NCAR being significant, but explaining only a small amount of the variation. They were however significant in predicting fertilizer (positive correlation), but marginally so for compost density.

What's interesting to note is that the climate controls also had a significant effect on literacy rates, but the effects appeared inverted between the two sexes. For male literacy rates, UDEL, NCAR, and Precipitation were each significant and negatively correlated. However, the exact opposite was true for female rates, although the effect was much weaker. Since these climate conditions are unlikely to be the actual cause behind changes in literacy rates, it's likely that this is due to long term institutional differences between northern and southern Korea. Literacy rates as noted previously were spatially split. In fact, every time the South dummy was added as a control, the climate variables become insignificant in predicting either female or male literacy rates. In some cases the sign of the relationship changed. On account of this, more work was done exploring the South dummy. It was discovered that outside of having an effect on each respective sex's literacy rate and on climate, the dummy also showed a significant and substantial divide on total plot size (but not paddy plot size) and fertilizer usage (positive) between the north and south. This dummy can also show whether an effect in being predominantly carried by processes occurring only in one part of the peninsula and therefore is employed in the multivariate regression model.

The relationship between income, literacy, and agricultural intensity was also considered. Income was positively correlated and explained some of the variability in literacy rates for both sexes. The effect however was about three times stronger for male than female literacy such that a 1% increase in income correlated with a 0.01% increase in male literacy rates. While this might not seem substantial, variance in income was much greater than in literacy. Movement from the lowest income county to the highest income one in fact would cause a predicted doubling in male literacy rates from 36% to 72%. This stronger effect is expected since families, given surplus income, would traditionally first invest in education for their male children and then for females. Hence, a smaller proportion of an increase in income would go to female education. Income was not significant in predicting the land use ratio and though it was significant in the case of land productivity, the relationship did not have strong explanatory power. However, income was able to predict a good amount of the variation in fertilizer usage and the two were positively correlated.

Before the multivariate model was run, the relations between the main independent intensity variables and literacy rates were examined. For Male literacy rates, only one of the three measures were significant and substantial, though not in the direction initially predicted. In the first measure, by holding the land use ratio constant and examining land productivity, the explanatory variable is shown to not be significant. However, land use ratio is highly significant and negative. This was seen earlier in the bivariate regression between the two and stems from land productivity not being significant. This same trend fueled the second finding: holding paddy size constant, land use still continued to have a negative correlation with male literacy. Though paddy size was significant, including it in fact strengthened the negative response of land use to male literacy. Neither fertilizer usage or compost were significant.

The relations for female literacy rates were much closer to what was expected. Controlling for land use, land productivity had a significant and substantial relation with female literacy - an increase in land productivity by one unit contributed to a 2.46% rise in literacy. Thus, a county with the lowest land productivity (9 koku/cho), by moving to the same level as the highest (46 koku/cho) would more than double female literacy from 3.6%-8.8%. In the second measure, by controlling for farm size, land use was found to be positive and statistically significant. The elasticity between measures was found to be 0.27, meaning that a 1% change in the land use ratio was associated with a 0.27% change in literacy. Excluding counties without any paddy at all, movement from the lowest to the highest ratio, while keeping the same farm size, was associated with over a tripling in literacy from 3.4%-11.2%. As expected, farm size was not significant. Finally, fertilizer usage, when controlling for farm size, was also significant, corresponding to a positive growth in literacy. Excluding countries where no fertilizer was reported to have been purchased, an increase from the lowest to the highest density of fertilizer usage (while keeping farm size constant) was predicted to result in an almost quadrupling of literacy rates from 6.5%-22.5%. Of course one doesn't simply shift all of their production to rice, especially if they had been stuck at a very low equilibrium where only 10% of their crop share was rice. Moreover, simply changing production overnight will not suddenly cause female literacy to rise. Still, being nudged from this lower to a higher equilibrium may overtime fuel a stronger demand for education,

4 Multivariate Regressions

4.0.1 Measure 1 — Labor Inputs

Multivariate Regression Model

$$Y_{it}^{s} = \beta_0 + \beta_1 L_{it}^{c} + \beta_2 X_i + \beta_3 Ln(I)_{it} + \beta_4 TS_{it} +_5 TY_{it} + \beta_6 PS_{it} + \beta_7 O_{it} + \beta_8 IND_{it} + \varepsilon$$

$$H_0 : \beta_1 = 0$$

$$H_1 : \beta_1 \neq 0$$

The question of whether labor intensification has an effect on literacy rates is taken up by this model by representing labor intensity as labor input, or the number of households cultivating a hectare of land. An OLS cross-sectional regression was conducted using labor input as the independent variable and 7 control variables including one dummy. Y_{it}^{s} represents literacy rates in county i at time t for sex s. L_{it}^{c} represents labor inputs in county i at time t for category c (total land, paddy land, and rice land). The controls are logged household income (I), the three climate controls average temperature for September (TS), temperature for the year (YS), & average precipitation in September (PS), the degree of landownership (O), and the extent of industrial development (IND).

In constructing this model, the null hypothesis is that land intensity will have no effect on literacy rates, while the alternative is that there is some effect such that the coefficient does not equal zero. It's predicted that land intensity will in fact positively correlate with literacy even after controls are added such that it has an independent effect on it. While having three possible measures of land inputs presents additional opportunities, there isn't information available to how many individuals worked or how many hours were put into each category of land, making interpreting categories that are subsections of total land difficult. In theory, paddy should show a stronger relationship than total land, and regressing with land actually used for rice cultivation should produce an even stronger effect since each of those areas are progressively smaller areas that would require more intensive work. However, without knowing the distribution of labor to each type of land, such an analysis is hard to argue. A small patch of paddy land that's mostly ignored might be part of a larger primarily-soy bean producing county sustaining many households, yet in this measure it would seem that the paddy were intensely cultivated. Knowing the land use ratio and using it as a control when regressing with the paddy and rice measurements should prevent such misrepresentations from occurring.

One question raised was whether to log transform the literacy measure. Doing so would certainly bring the distribution closer to being normal. Differences between counties might be better highlighted

Table 1.1: Labor Inputs (Male)

	(1) Literacy(M)	(2)	(3)	(4)	(5)	(6)	(7)
Labor_Total	-0.250***	-0.110***	-0.0574**	-0.0568*	-0.0284		
	(-12.65)	(-4.38)	(-2.03)	(-1.84)	(-0.91)		
South		-0.124***	-0.142***	-0.167***	-0.169***	-0.179***	-0.180***
		(-7.80)	(-8.75)	(-8.43)	(-8.45)	(-9.39)	(-9.44)
Income			0.000211***	0.000180***	0.000156***	0.000173***	0.000173***
			(3.62)	(3.04)	(2.62)	(3.19)	(3.17)
Temp_Sept				-0.0104*	-0.0141**	-0.0210***	-0.0204***
				(-1.80)	(-2.42)	(-3.67)	(-3.58)
Temp_Yearly				0.00728**	0.00763**	0.00838***	0.00816***
				(2.33)	(2.48)	(2.71)	(2.64)
Precip_Sept				0.000539	0.000309	0.000140	0.000163
				(1.49)	(0.88)	(0.39)	(0.46)
Own_Land					-0.0891**	-0.0511	-0.0526
					(-2.01)	(-1.10)	(-1.13)
Industry					0.000197	0.0000600	0.0000690
					(0.50)	(0.16)	(0.18)
Labor_Paddy						0.00608**	
						(2.08)	
Land_Ratio						0.116***	0.111***
						(3.03)	(2.93)
Labor_Rice							0.00549*
							(1.88)
N	213	213	213	212	205	203	203
R-sq	0.431	0.559	0.585	0.612	0.637	0.652	0.650

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 1.2: Labor Inputs (Female)

	(1) Literacy(F)	(2)	(3)	(4)	(5)	(6)	(7)
Labor_Total	0.00606	-0.0481***	-0.0118	-0.00804	0.00289		
	(0.68)	(-4.09)	(-0.92)	(-0.56)	(0.20)		
South		0.0479***	0.0353***	0.0342***	0.0324***	0.0287***	0.0287***
		(6.42)	(4.81)	(3.71)	(3.47)	(3.19)	(3.20)
Income			0.000147***	0.000145***	0.000120***	0.000103***	0.000101***
			(5.58)	(5.26)	(4.34)	(4.03)	(3.95)
Temp_Sept				-0.00249	-0.00361	-0.00311	-0.00326
				(-0.93)	(-1.33)	(-1.16)	(-1.22)
Temp_Yearly				0.00114	0.000894	0.000504	0.000570
				(0.79)	(0.62)	(0.35)	(0.39)
Precip_Sept				0.0000692	-0.0000182	0.00000573	0.00000436
				(0.41)	(-0.11)	(0.03)	(0.03)
Own_Land					-0.0709***	-0.0636***	-0.0632***
					(-3.43)	(-2.92)	(-2.90)
Industry					0.000186	0.000158	0.000153
					(1.01)	(0.87)	(0.84)
Labor_Paddy						-0.00256*	
						(-1.85)	
Land_Ratio						0.00274	0.00283
						(0.15)	(0.16)
Labor_Rice							-0.00270*
							(-1.97)
N	213	213	213	212	205	203	203
R-sq	0.002	0.166	0.274	0.278	0.302	0.307	0.309

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

when examining proportional, rather than absolute, differences between them. However, the relation between different counties appeared more linear than exponential (although the highest quartile of female rates were distributed exponentially). Hence, the main regressions were done without log transforming the dependent variable. In a few examples however the results with the dependent variable log transformed will be noted if an interesting relationship is revealed by it. An additional issue was where the significance threshold α would be set. Though setting it at 0.05 is common in order to minimize the probability of a type one error, using historical data presents substantial difficulties in terms of the statistical noise that's often a part of the data. Issues in copying, translating, measuring, and verifying information were much more substantial then than in the age of modern data. In consideration of this an a desire not to allow a type two error to occur on account of this noise, an α of 0.10 was used.

Tables 1.1&1.2 report the results for both male and female literacy, respectively. While the measure of intensity that included total land worked was not a significant predictor of either male or female literacy, measures that narrowed in on paddy and rice land were significant, allowing the null hypothesis to be rejected. However, while the relationship with male literacy was positive, it was negative with female rates. Both effects were not very substantial. Increasing labor input by an additional household per hectare of paddy corresponded with a 0.6 percentage point increase in male literacy (1.47% increase when logged) while also being associated with a decrease in female literacy of 0.3 percentage points (4.79% decrease when logged)[76]. The effects when accounting for cultivated rice area were similar, but slightly weaker. The reason why paddy and rice land were significant as opposed to total land was probably due to the fact that they require more labor and thus are more sensitive to decisions to intensify.

Uncontrolled for Divergence Between North & South The South dummy was consistently highly significant for both sexes, but it was negative in the case of male literacy and positive for female. This is

[76]An additional household per acre paddy would be the equivalent of moving from about the 25th to the 75th percentile of counties, or from around the 75th to the 90th percentile.

not surprising since it's already been noted that male literacy was much higher in the north and female in the south. However, its persistence in columns (6) & (7) shows that outside of income, land intensity, land tenancy patterns, and industry effects that affected the north and south literacy levels locally, there were other factors causing this spacial separation in literacy rates.

Higher Labor Intensity in Northern Rice Culture Since overall labor inputs were lower in the north (based on larger farm sizes) where male literacy rates were also higher, one would expect the relationship between labor inputs and male literacy to be inverse. However in the case of paddy and rice land, labor inputs actually increased in the north since paddy land was much sparser. Hence it would make sense that there would be a positive correlation with male and a negative one with female literacy. One concern is that smaller paddy fields in areas of higher male literacy aren't actually seeing high labor inputs. That is, if the distribution of hours of work put into the paddy field as compared to dry crops were available, it would show that the vast majority of work in such regions (i.e. the north) was going into dry crops, voiding the findings from this model. Yet the relationship continued to be significant even after being controlled for environmental conditions. Regions with the same climate would have little reason to not put the same amount of labor into each type of crop, or at the least these differences should balance out. The fact the relationship was still significant after the land ratio control meant that, at least when comparing within the north and south, those who put more labor into similar environmental conditions and land ratios were able to earn an unexpected return in education. Table 1.3 shows that labor intensity of inputs prevailed more in the north.

TABLE 1.3

Labor Intensity Correlated with Lower Female Literacy This finding goes against this study's hypothesis and raises the question of whether male and female literacy rates depend on different factors.

	(1)	
	Labor_Paddy	
South	-1.244***	(-2.71)
Land_Ratio	-5.191***	(-6.09)
Income	-1.083***	(-3.00)
Temp_Sept	0.293**	(2.12)
Temp_Yearly	-0.0807	(-1.06)
Precip_Sept	0.0218**	(2.54)
Own_Land	-0.797	(-0.71)
Industry	-0.00182	(-0.19)
Observations	203	
R^2	0.364	

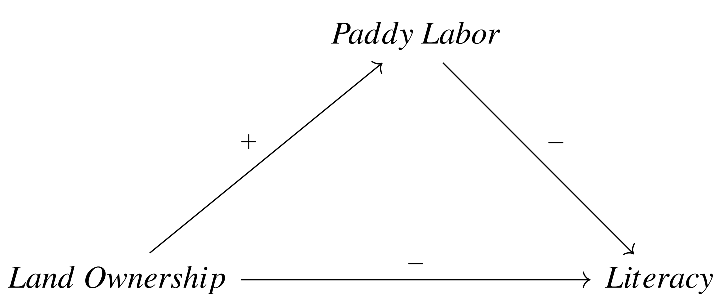
t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

This issue was raised earlier when a bivariate regression of both rates found no correlation. Analyzing this through labor inputs shows a few theories that can be explored. Higher labor inputs generally mean smaller household landholdings and a more densely packed population. In such a competitive environment, constrained families may believe that putting all of their educational investments into male children would provide the best opportunity for social and economic advancement. Moreover, while households may become ”pluri-active”, labor itself may become more specialized by gender. Tangental evidence on gender dynamics comes from the successful appeal the Christian missionaries had on Korean women. During the surge of membership in the Great Revival of 1907, Korean ”biblewomen” were sought for their ability to make contact with ”respectable Korean women.”[77]. Women's education soon became an joint effort by western and Korean missionaries who opened up schools, bible institutes, and seasonal institutes for farm women to attend in the city in the Korean northwest. Pyongyang would soon be called the ”Jerusalem of the East” in no small part due to the work biblewomen did to bring Christianity into the home.[78] Such success was not found in the southern half of the country, though much of this may have been due to weariness of outside influences.

[77]Clark,244
[78]Ibid,245

Owning Land and Lower Literacy The Own Land variable did not behave in the way it was expected to. Though land ownership was more widespread in the north, it had a negative influence on both male & female literacy rates and on labor inputs. Though economic principle would argue that it is "proverbial that the man who holds a stake in the land he tills is more enterprising...than the tenant"[79], tilling one own's land appeared to be a sign of illiteracy. Land ownership's addition to the model reduced the significance of total labor inputs for predicting female literacy (Table 1.2, Column 5) and made their effect completely insignificant for male literacy (Table 1.1, Column 5). This suggests that much of the inverse correlation between labor inputs in total land and male literacy originates in the direct relation between landownership and labor inputs. However, land ownership was not a significant predictor for male rates when controlled for inputs to either paddy or rice land (Table 1.1, Columns 6 & 7). This made it difficult to evaluate its overall effects on the measurement. However, it was significant in predicting female rates using any of the three labor input measurements. Since the relation between landholding and female literacy was negative, and the relation between labor inputs and female literacy was also negative, the relation between land ownership and labor inputs should be positive.

Figure X



This was not what was expected as owning one own's land should provide the economic security to proceed with investments in education, but made sense in the context of the times. Being a period of economic downturn, many families were induced to sell large tracts of their land in the 1930's. It may be

[79]Hamilton

the case that regions in which fewer families had to sell their land were not richer, but less connected to the new global economy. In exchange for minimizing the commercialization of their crops, households in these regions were able to keep in place a greater portion of the old land regime. They may be have been less accessible and had a higher preference for a traditional social structure and therefore been skeptical on the idea of women's literacy. Following measures will hopefully shed more light on these issues.

4.0.2 Measure 2 — Complementary Goods

Multivariate Regression Model

$$\mathrm{Y_{it}}^{\mathrm{s}} = \beta_0 + \beta_1 F_{it}^{c} + \beta_2 X_i + \beta_3 Ln(I)_{it} + \beta_4 TS_{it} +_5 TY_{it} + \beta_6 PS_i + \beta_7 O_{it} + \beta_8 IND_{it} + \varepsilon$$

$$\mathrm{H}_0 : \beta_1 = 0$$

$$\mathrm{H}_1 : \beta_1 \neq 0$$

The question of whether labor intensification has an effect of literacy rates is taken up by this model by representing labor intensity as the addition of labor-absorbing complementary goods, or more specifically the density of fertilizer usage. An OLS cross-sectional regression was conducted using an independent variable for labor intensity and 7 control variables including one dummy variable. Y_{it}^{s} represents literacy rates in county i at time t for sex s. F_{it}^{c} represents fertilizer inputs in county i at time t for category c (self-produced or ”compost” and market bought or ”fertilizer”). The controls are logged household income (I), the three climate controls average temperature for September (TS), temperature for the year (YS), & average precipitation in September (PS), the degree of landownership (O), and the extent of industrial development (IND). In constructing this model, the null hypothesis is that fertilizer usage will have no effect on literacy rates, while the alternative is that there is some effect such that the coefficient does not equal zero.

The effects of the fertilizers are similar in that they both are intermediary goods that increase the marginal productivity of labor my shifting its output elasticity. One way to conceptualize the difference between them is in terms of TFP change. The new fertilizers that the Japanese were exporting and creating in agricultural experimentation stations was a crucial component in raising yields in Korea during the colonial era. In this way, usage of the two fertilizers can be thought of as representing two steps within the labor-intensive path of development beginning with labor-absorbing inputs and transitioning to productivity-enhancing ones. An important question to ask is whether this fertilizer is being applied to rice or to other crops and whether one would expect a different effect on literacy based on this decision. It would naturally make most sense to apply fertilizer to the higher yielding and greater labor absorbing crop. Adding the land use ratio as an additional control would be one way to get at this question.

Tables 2.1 & 2.2 report the results for both male and female literacy, respectively. The study found that through there was no effect of fertilizer density on male literacy rates, there was a significant correlation between it and female literacy. The correlation was such that an additional $1,000$ yen expenditure on market purchased fertilizer per km^2 of cultivated land was associated with a 1 percentage point increase in female literacy. This may appear to not be a substantial relationship, especially when the average household income is around 260 yen. However, a square kilometer of cultivated land is a substantial areas consisting of 100 hectares and an average of 63 households' farm area. Hence, with each family funding an additional 15.87 yen, the associated benefit in female literacy would on average amount of one percentage point. This is substantial considering that 5 percentage points separate the county at the 25th percentile from the one at the 75th. However, since only in one out of four cases was the coefficient statistically significant, we cannot reject the null that there is no effect of fertilizer usage on literacy. The effect of fertilizer was initially more than twice as significant. However controlling for income unsurprisingly decreased its effect drastically (Table 2.2, Column 2).The same pattern occurred for male literacy, but the result was that the fertilizer measurement lost all significance (Table 2.1, Column 2).

Table 2.1: Complementary Inputs (Male)

	(1) MaleLiteracy	(2) MaleLiteracy	(3) MaleLiteracy	(4) MaleLiteracy	(5) MaleLiteracy	(6) MaleLiteracy
Fertilizer	-0.0000290**	0.0000290***	0.00000479	0.0000145	0.0000123	
	(-2.41)	(3.18)	(0.46)	(1.28)	(1.08)	
South		-0.190***	-0.170***	-0.185***	-0.179***	-0.179***
		(-15.34)	(-13.18)	(-9.95)	(-9.58)	(-9.67)
Income			0.000256***	0.000191***	0.000145**	0.000176***
			(4.24)	(3.08)	(2.32)	(3.37)
Temp_Sept				-0.0153***	-0.0173***	-0.0176***
				(-2.72)	(-3.05)	(-3.15)
Temp_Yearly				0.00726**	0.00759**	0.00855***
				(2.31)	(2.47)	(2.75)
Precip_Sept				0.000723*	0.000434	0.000368
				(1.95)	(1.20)	(1.05)
Own_Land					-0.0867*	-0.102**
					(-1.95)	(-2.34)
Industry					0.0000834	0.000103
					(0.21)	(0.27)
Compost						0.0137
						(1.60)
N	213	213	213	212	205	205
R-sq	0.027	0.541	0.577	0.609	0.637	0.640

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 2.2: Complementary Inputs (Female)

	(1) FemaleLite~y	(2) FemaleLite~y	(3) FemaleLite~y	(4) FemaleLite~y	(5) FemaleLite~y	(6) FemaleLite~y
Fertilizer	0.0000258***	0.0000216***	0.00000940**	0.0000134**	0.0000107**	
	(6.85)	(5.29)	(2.03)	(2.60)	(2.02)	
South		0.0137**	0.0241***	0.0283***	0.0303***	0.0334***
		(2.47)	(4.23)	(3.32)	(3.50)	(3.86)
Income			0.000130***	0.000111***	0.0000861***	0.000119***
			(4.84)	(3.91)	(2.99)	(4.85)
Temp_Sept				-0.00437*	-0.00463*	-0.00321
				(-1.70)	(-1.77)	(-1.23)
Temp_Yearly				0.000912	0.000745	0.000781
				(0.64)	(0.52)	(0.54)
Precip_Sept				0.000178	0.0000597	-0.0000248
				(1.05)	(0.36)	(-0.15)
Own_Land					-0.0615***	-0.0695***
					(-3.00)	(-3.42)
Industry					0.000145	0.000196
					(0.80)	(1.08)
Compost						-0.00172
						(-0.43)
N	213	213	213	212	205	205
R-sq	0.182	0.205	0.285	0.300	0.316	0.302

t statistics in parentheses
* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Labor Inputs Promote Male & Complementary Inputs Promote Female Literacy Noting these results in relation to those from the first measure, it's interesting to find that the relationship between fertilizer usage and female literacy is analogous to the relationship between labor inputs and male literacy in the first measure. That is, while labor inputs had a significant and positive effect on male literacy, complementary labor inputs are significant and positive for female literacy. This may be due to incentives related to the production function. Consider that the marginal product of labor begins growth at an increasing rate. The rate of growth then decreases as labor is employed in increasingly less productive tasks until it begins its approach to zero. Supposing then that decreases in marginal labor productivity have begun to set in and the decision of whether to have women work in the field is brought into consideration by the household. Certainly there is still a need to gather all available labor during the harvest season as labor productivity rises significantly. However, during the rest of the year a separation of occupations based on sex will more likely occur. However, the addition of labor complementary inputs raises the output elasticity of labor, causing marginal productivity to both rise faster and decline slower than it would have otherwise. In such a scenario, the benefit of including more household members in the cultivation process rises.

Tenancy Encourages Transition to New Fertilizer Land ownership was again a significant predictor of literacy rates for both sexes, allowing for its effects on labor intensity to be investigated further. As was discovered in the previous measure, land ownership had an inverse relationship with literacy rates, but a direct one with land intensity (labor inputs). In terms of fertilizer usage however, the relationship was more complex.

TABLE 2.3

As table 2.3 shows, landownership encouraged the usage of self-produced fertilizer (compost) just as it was associated with higher labor inputs, but it discouraged the adoption of modern fertilizer inputs. As

	(1) Ln(Compost)		(2) Ln(Fertilizer)	
Own_Land	0.635*	(1.89)	−1.194**	(−2.51)
South	0.346***	(2.68)	0.0346	(0.19)
Income	−0.143	(−1.33)	1.036***	(6.77)
Temp_Sept	0.0764***	(2.94)	0.217***	(5.89)
Industry	−0.000759	(−0.28)	0.00783**	(2.01)
Labor_Paddy	0.0120	(0.40)	−0.179***	(−4.20)
Land_Use	0.197	(0.71)	0.730*	(1.86)
Observations	190		190	
R^2	0.368		0.664	

t statistics in parentheses
* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

argued in the previous measure, it may be the case that those who continued to own the land they tilled into the 1930's were economically disconnected from the global market. They were still labor intensive cultivators, but were divorced from many of the technological changes occurring around them. Moreover, though a shift to a new fertilizer is closer to a change in TFP, the fertilizer is still a labor-absorbing input affecting output elasticity. As discussed above, a change in output elasticity may be more advantageous to women actively participating in labor-intensive growth.

4.0.3 Measure 3 — Land Use Ratio

Multivariate Regression Model

$$\mathrm{Y_{it}}^{\mathrm{s}} = \beta_0 + \beta_1 LR_{it} + \beta_2 FS + \beta_3 X_i + \beta_4 Ln(I)_{it} + \beta_5 TS_{it} +_6 TY_{it} + \beta_7 PS_i + \beta_8 O_{it} + \beta_9 IND_{it} + \varepsilon$$

$$\mathrm{H}_0 : \beta_1 = 0$$

$$\mathrm{H}_1 : \beta_1 \neq 0$$

The question of whether labor intensification has an effect of literacy rates is taken up by this model by representing labor intensity as the land use ratio or more specifically the percentage of paddy land cultivated of all cultivated land. An OLS cross-sectional regression was conducted using an independent variable for labor intensity and 8 control variables including one dummy variable. Y_{it}^{s} represents literacy rates in county i at time t for sex s. LR_{it} represents the land use ratio in county i at time t. The controls are farm size (FS), the south dummy (S), logged household income (I), the three climate controls average temperature for September (TS), temperature for the year (YS), & average precipitation in September (PS), the degree of landownership (O), and the extent of industrial development (IND). In constructing this model, the null hypothesis is that fertilizer usage will have no effect on literacy rates, while the alternative is that there is some effect such that the coefficient does not equal zero.

Tables 3.1 & 3.2 report the results for both male and female literacy, respectively. The land ratio was significant in predicting male literacy rates such that movement from cultivating no rice to only growing rice corresponded to an 8 percentage point (or a 20.95% when logged) increase in male literacy. Movement from the 25th to the 75th percentile still offered a substantial increase of 8.14%. However, the land use ratio was unable to predict female literacy rates (Table 3.2, Column 5). Therefore, while the null hypothesis can be rejected in the case of male literacy, this cannot be done for female literacy as further research needs to be conducted. Thankfully, the cause of this differentiated effect is easy to locate. The addition of land ownership was the main cause of the land ratio's decline in predicative power. Land ownership did not have the same effect in the model with male literacy, confirming the evidence from previous measures that higher rates of land ownership particularly affect female literacy rates. However, unlike in previous measurements land ownership was inversely correlated with the labor intensity statistic. This means that regardless of climate, income, or spacial reference, those who cultivated their own land avoided converting it to paddy. Returning the relation to its historical context, one can again see the effects of the 1930's economic slump. With a global collapse in rice prices, those who had converted a larger portion of their land to rice to sell on this market had the most to lose.

Table 3.1: Land Use Ratio (Male)

	(1) MaleLiteracy	(2) MaleLiteracy	(3) MaleLiteracy	(4) MaleLiteracy	(5) MaleLiteracy
Land_Ratio	0.0132	0.114***	0.0652**	0.0864**	0.0786**
	(0.39)	(3.68)	(2.02)	(2.55)	(2.17)
Farm_Size	0.0699***	0.0213**	0.00488	0.00761	-0.00493
	(9.18)	(2.52)	(0.53)	(0.82)	(-0.53)
South		-0.174***	-0.181***	-0.186***	-0.191***
		(-8.97)	(-9.58)	(-8.84)	(-9.12)
Income			0.000230***	0.000178***	0.000165***
			(3.92)	(3.00)	(2.82)
Temp_Sept				-0.0157***	-0.0190***
				(-2.85)	(-3.39)
Temp_Yearly				0.00734**	0.00740**
				(2.33)	(2.40)
Precip_Sept				0.000530	0.000283
				(1.47)	(0.81)
Own_Land					-0.0602
					(-1.28)
Industry					0.00000708
					(0.02)
N	213	213	213	212	205
R-sq	0.383	0.554	0.585	0.618	0.646

t statistics in parentheses

* p<0.10, ** p<0.05, *** p<0.01

Table 3.2: Land Use Ratio (Female)

	(1) FemaleLite~y	(2) FemaleLite~y	(3) FemaleLite~y	(4) FemaleLite~y	(5) FemaleLite~y
Land_Ratio	0.0715***	0.0559***	0.0252*	0.0312**	0.0114
	(5.25)	(3.90)	(1.74)	(1.98)	(0.67)
Farm_Size	0.00373	0.0113***	0.000908	-0.0000819	-0.00473
	(1.22)	(2.88)	(0.22)	(-0.02)	(-1.08)
South		0.0272***	0.0232***	0.0273***	0.0264***
		(3.01)	(2.74)	(2.80)	(2.68)
Income			0.000145***	0.000139***	0.000124***
			(5.53)	(5.05)	(4.53)
Temp_Sept				-0.00377	-0.00408
				(-1.47)	(-1.55)
Temp_Yearly				0.000940	0.000610
				(0.64)	(0.42)
Precip_Sept				0.0000546	-0.0000264
				(0.33)	(-0.16)
Own_Land					-0.0662***
					(-3.01)
Industry					0.000139
					(0.75)
N	213	213	213	212	205
R-sq	0.141	0.177	0.282	0.292	0.309

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Focus of Growth Was Intensive, Not Extensive The major concern of using the land ratio as a proxy for labor intensive growth was that proportion could be increased extensively by expanding land inputs. However, the addition of farm size as a control did not substantially change the effect of land ratio. While the model is still controlling for farm size to examine intensive growth, the fact that the land ratio doesn't change much means that there is not much extensive growth happening. Another possibility is that what extensive growth is happening is, as one would expect, not affecting literacy rates.

4.0.4 Measure 4 — Land Productivity

Multivariate Regression Model

$$Y_{it}^{s} = \beta_0 + \beta_1 LP_{it} + \beta_2 LR_{it} + \beta_3 X_i + \beta_4 Ln(I)_{it} + \beta_5 TS_{it} +_6 TY_{it} + \beta_7 PS_i + \beta_8 O_{it} + \beta_9 IND_{it} + \varepsilon$$

$$H_0 : \beta_1 = 0$$

$$H_1 : \beta_1 \neq 0$$

The question of whether labor intensification has an effect of literacy rates is taken up by this model by proxying labor intensity as a measure of land productivity or more specifically the amount of rice yields per area planted. An OLS cross-sectional regression was conducted using an independent variable for labor intensity and 8 control variables including one dummy variable. Y_{it}^{s} represents literacy rates in county i at time t for sex s. LP_{it} represents labor productivity in county i at time t. LR_{it} represents the land use ratio in county i at time t. The remaining controls the south dummy (S), logged household income (I), the three climate controls average temperature for September (TS), temperature for the year (YS), & average precipitation in September (PS), the degree of landownership (O), and the extent of industrial development (IND). In constructing this model, the null hypothesis is that land productivity will have no effect on literacy rates, while the alternative is that there is some effect such that the coefficient does not equal zero.

Tables 4.1 & 4.2 report the results for both male and female literacy, respectively. While land productivity wasn't a significant predictor for male literacy rates, it was significant for female rates such that an increase in yields of one koku/cho was associated with a 0.124 percentage point (or 1.99% when logged). This was a moderately significant effect since productivity measures ranged from 9 to as higher as 45 koku/cho. Movement from the lowest to the highest productivity is associated then with a 4.34 percentage point increase in female literacy rates, or movement from the 25th to a bit under the 75the percentile. For this reason the null hypothesis in the case of female literacy is rejected. When discussing the effect of labor absorbing practices on land productivity, it was argued that an increase in labor absorption capabilities would cause marginal land productivity to increase. Since the previous measures have shown that labor absorbing processes had a greater effect on female literacy rates it is to be expected that land productivity will follow a similar pattern.

Table 4.1: Land Productivity (Male)

	(1) MaleLiteracy	(2) MaleLiteracy	(3) MaleLiteracy	(4) MaleLiteracy	(5) MaleLiteracy	(6) MaleLiteracy	(7) MaleLiteracy
Land_Product	-0.00225*	0.00159*	0.000318	0.000722	0.000617	0.000484	0.000225
	(-1.72)	(1.69)	(0.34)	(0.77)	(0.68)	(0.54)	(0.22)
South		-0.179***	-0.168***	-0.183***	-0.178***	-0.188***	-0.187***
		(-15.04)	(-14.58)	(-9.87)	(-9.52)	(-9.91)	(-8.80)
Income			0.000266***	0.000223***	0.000170***	0.000144**	0.000198***
			(5.06)	(4.13)	(3.09)	(2.58)	(3.14)
Temp_Sept				-0.0149***	-0.0169***	-0.0196***	-0.0167***
				(-2.61)	(-2.96)	(-3.41)	(-2.93)
Temp_Yearly				0.00811**	0.00826***	0.00808**	0.00742**
				(2.51)	(2.60)	(2.58)	(2.25)
Precip_Sept				0.000620*	0.000344	0.000279	0.000349
				(1.71)	(0.98)	(0.80)	(1.00)
Own_Land					-0.0942**	-0.0549	-0.0988**
					(-2.16)	(-1.19)	(-2.24)
Industry					0.000134	0.0000407	0.0000592
					(0.34)	(0.11)	(0.15)
Land_Ratio						0.0824**	
						(2.35)	
Farm_Size							-0.00922
							(-0.91)
N	213	213	213	212	205	205	205
R-sq	0.014	0.525	0.577	0.607	0.636	0.646	0.638

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

Table 4.2: Land Productivity (Female)

	(1) FemaleLite~y	(2) FemaleLite~y	(3) FemaleLite~y	(4) FemaleLite~y	(5) FemaleLite~y	(6) FemaleLite~y	(7) FemaleLite~y
Land_Product	0.00216***	0.00173***	0.00105**	0.00130***	0.00126***	0.00124***	0.00125***
	(5.11)	(4.06)	(2.56)	(3.05)	(3.04)	(2.98)	(2.73)
South		0.0200***	0.0262***	0.0288***	0.0296***	0.0281***	0.0295***
		(3.71)	(5.17)	(3.42)	(3.49)	(3.22)	(3.04)
Income			0.000143***	0.000129***	0.0000941***	0.0000899***	0.0000945***
			(6.17)	(5.25)	(3.75)	(3.51)	(3.28)
Temp_Sept				-0.00499*	-0.00542**	-0.00586**	-0.00542**
				(-1.93)	(-2.09)	(-2.21)	(-2.08)
Temp_Yearly				0.00220	0.00193	0.00190	0.00192
				(1.51)	(1.34)	(1.32)	(1.28)
Precip_Sept				0.0000839	-0.0000153	-0.0000256	-0.0000152
				(0.51)	(-0.10)	(-0.16)	(-0.10)
Own_Land					-0.0653***	-0.0591***	-0.0654***
					(-3.29)	(-2.77)	(-3.26)
Industry					0.000183	0.000168	0.000182
					(1.03)	(0.94)	(1.00)
Land_Ratio						0.0131	
						(0.81)	
Farm_Size							-0.000116
							(-0.03)
N	213	213	213	212	205	205	205
R-sq	0.110	0.165	0.293	0.308	0.333	0.335	0.333

t statistics in parentheses
* p<0.10, ** p<0.05, *** p<0.01

5 Conclusion

This study showed that labor intensity, particularly in rice cultivation, had an effect on rural literacy rates during the Japanese colonial era, though the effects were highly differentiated by sex. Counties that engaged in labor absorbing practices particularly saw increases in female literacy. However, impact of these findings go beyond the colonial rural context. As mass urbanization radically shifted the demographic patterns of post-war South Korea, the social structures, values, and practices of the rural rice cultivator were transferring to a new modern urban context. Yet culture persists, and as the country positioned itself as a exporter of complex manufactured goods, it was able to tap into a workforce with high human capital accustomed to investing into skills. The northern half of the country, once poised to be the engine of growth for the peninsula, saw ruin of its economic and human capital infrastructure. Leading regions of labor intensive cultivation were encouraged to replace labor inputs with capital in one of the egregious attempts to impose foreign economic frameworks on a system that had been previously full of vitality. For development, research into theories of induced and labor intensive development showcase the need to adapt economic theory to the institutional context. This doesn't necessarily mean a re-working of the basic theory. In fact, the idea that people respond to incentives continues to be the pillar of any sound economic intervention and in many contexts has not been carried far enough to examine decision-making processes (this study explored such thinking on the topic of education). Future interventions to raise education should examine the issue from both the supply and the demand side to better understand just how interrelated different sectors of the economy are.

6 Appendix

6.1 Figures

Figure 1.1: Colonial Investments in Education

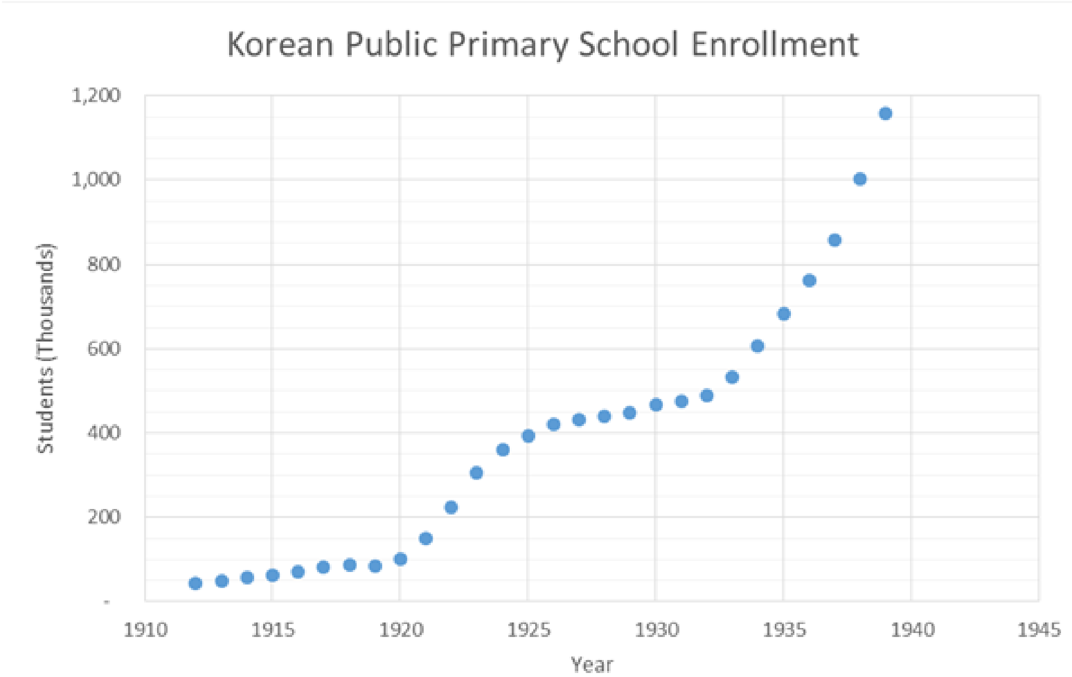


Figure 1.2: Colonial Investments in Education

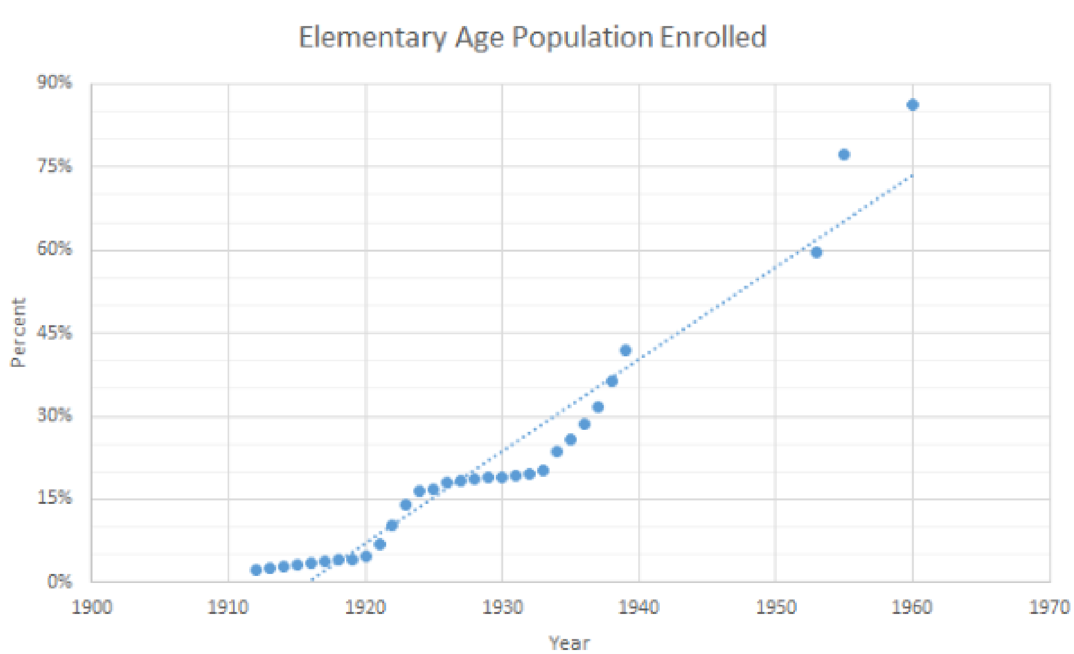


Figure 2.1: Cross-Check Literacy, Combined

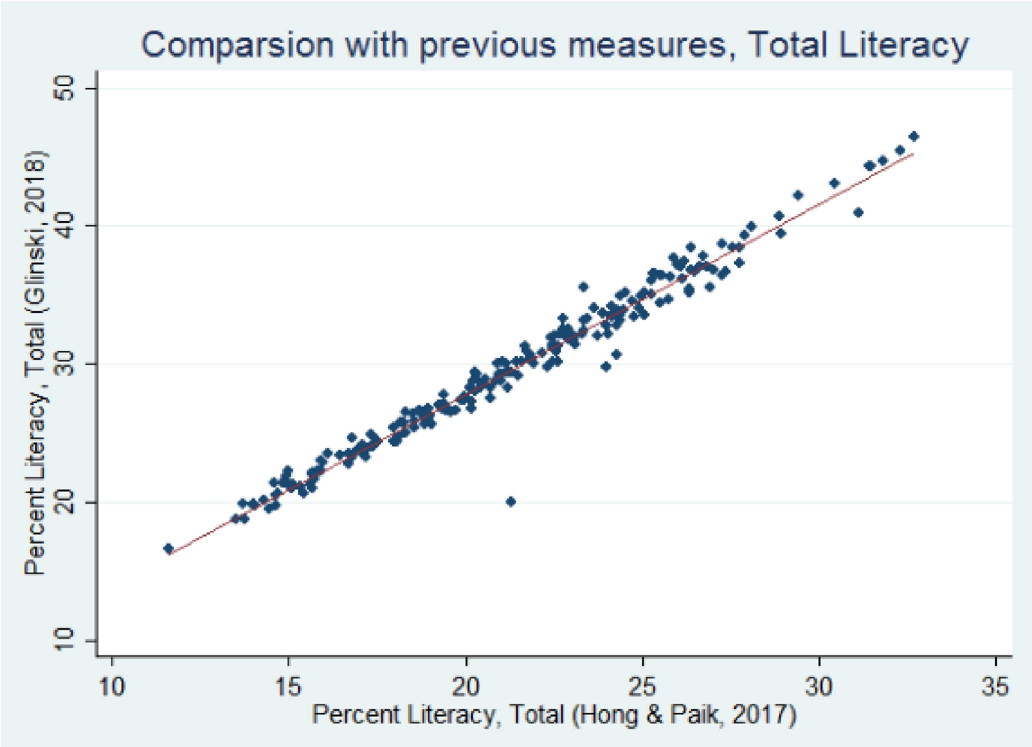


Figure 2.2: Cross-Check Literacy, Female

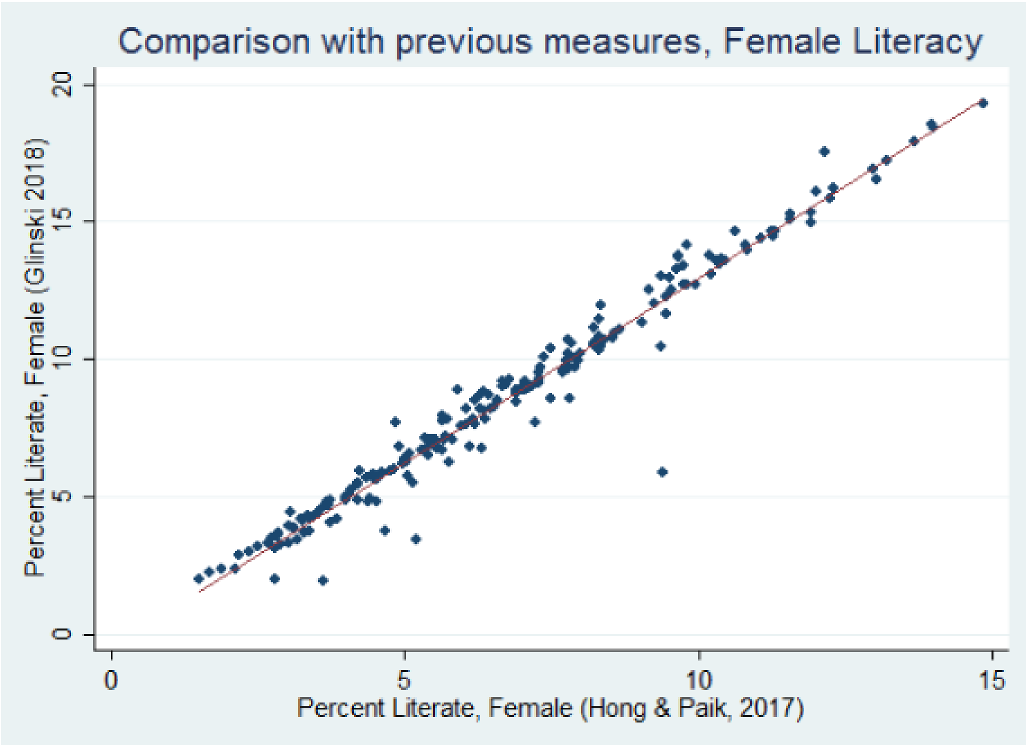
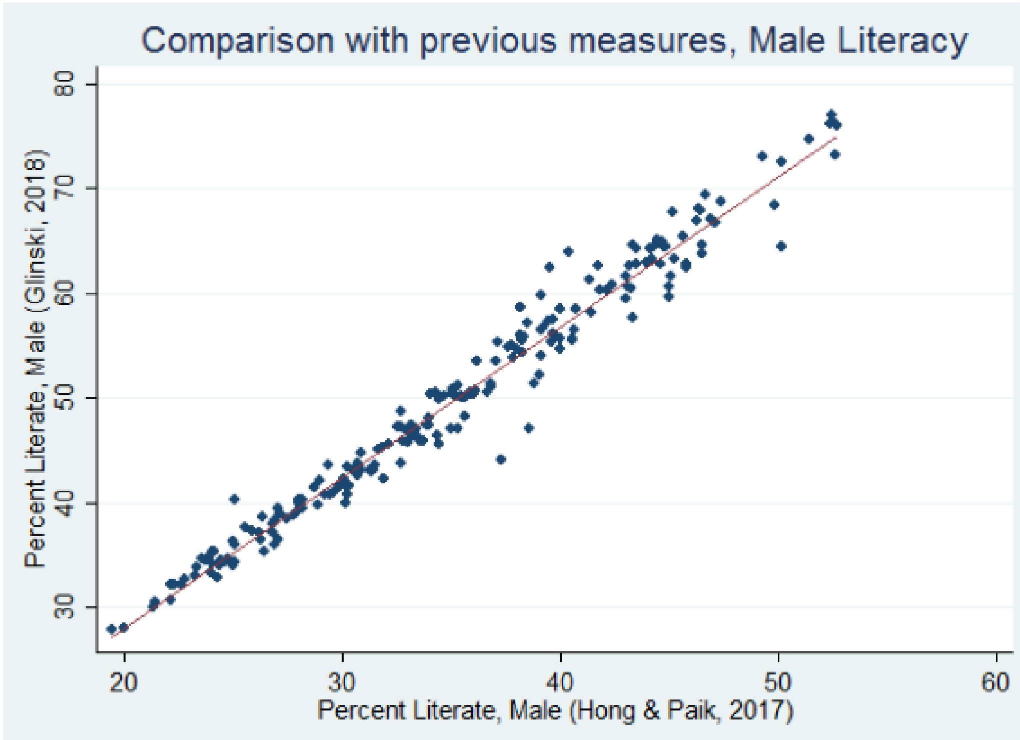
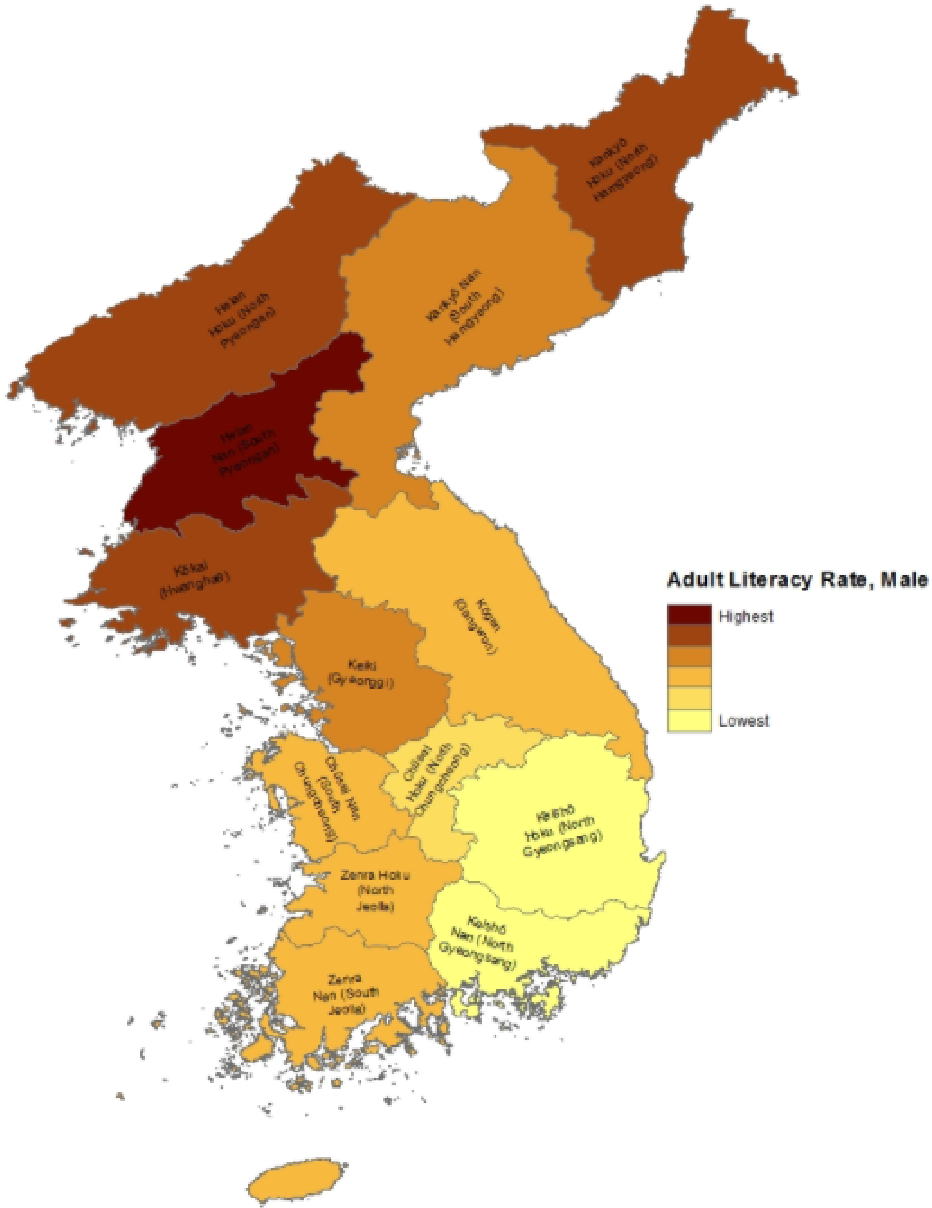


Figure 2.3: Cross-Check Literacy, Male

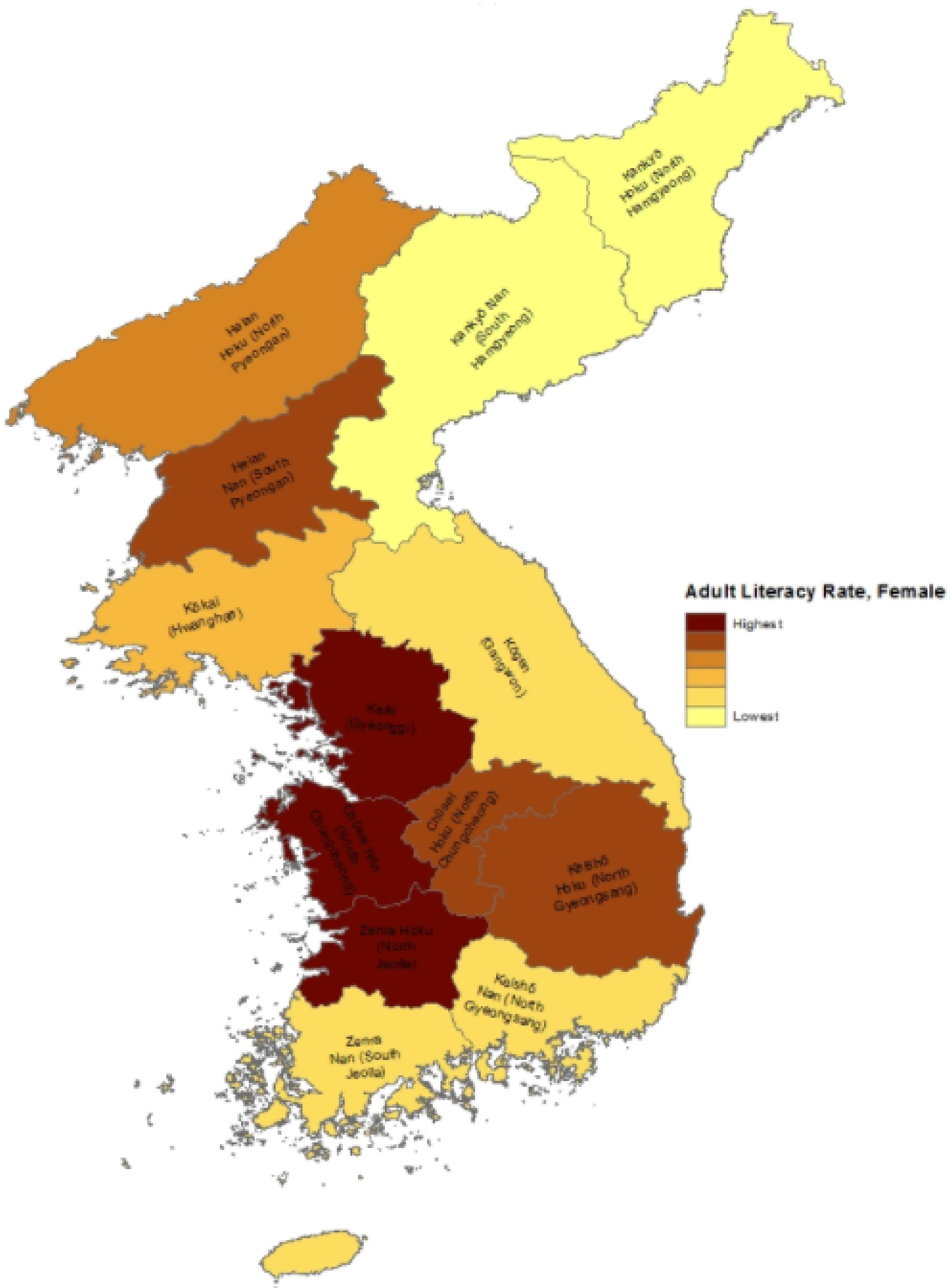


6.2 Maps

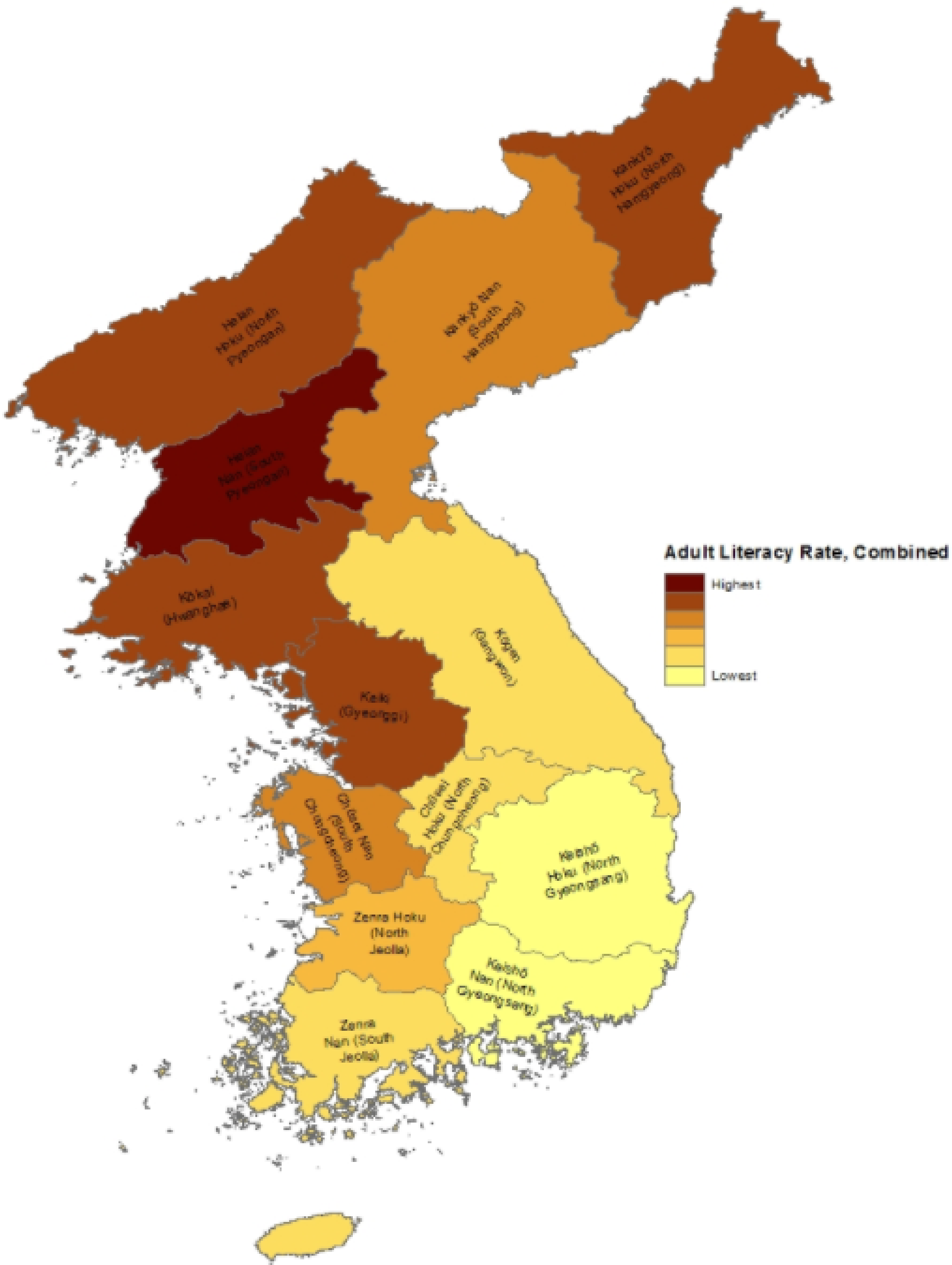
Map 1.1: Literacy Rate, Male (1930)



Map 1.2: Literacy Rate, Female (1930)



Map 1.3: Literacy Rate, Combined (1930)



Map 2.1: Total Plot Size

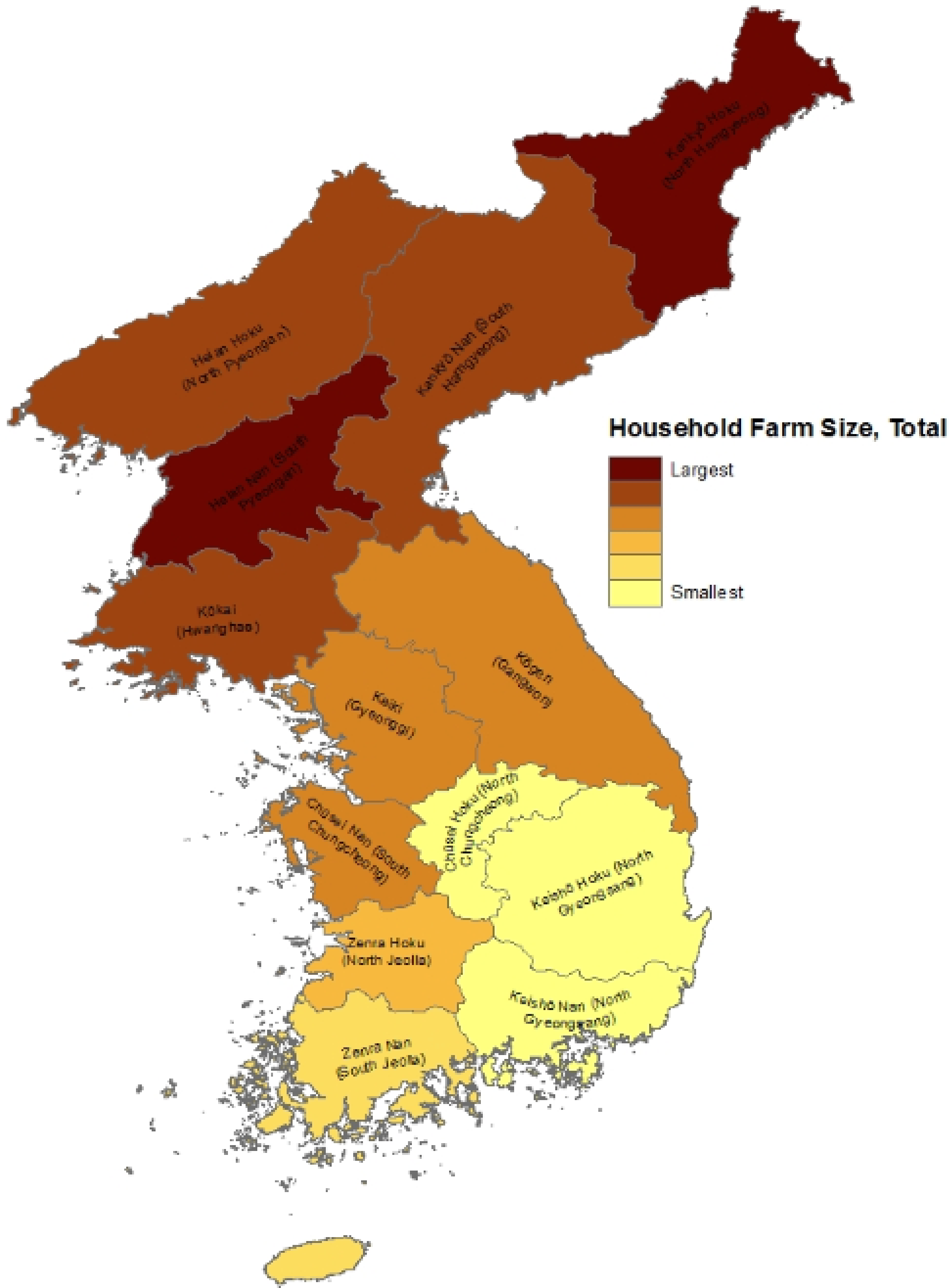


Figure 1: The inverse can be used to measure labor input.

Map 2.2: Paddy Plot Size

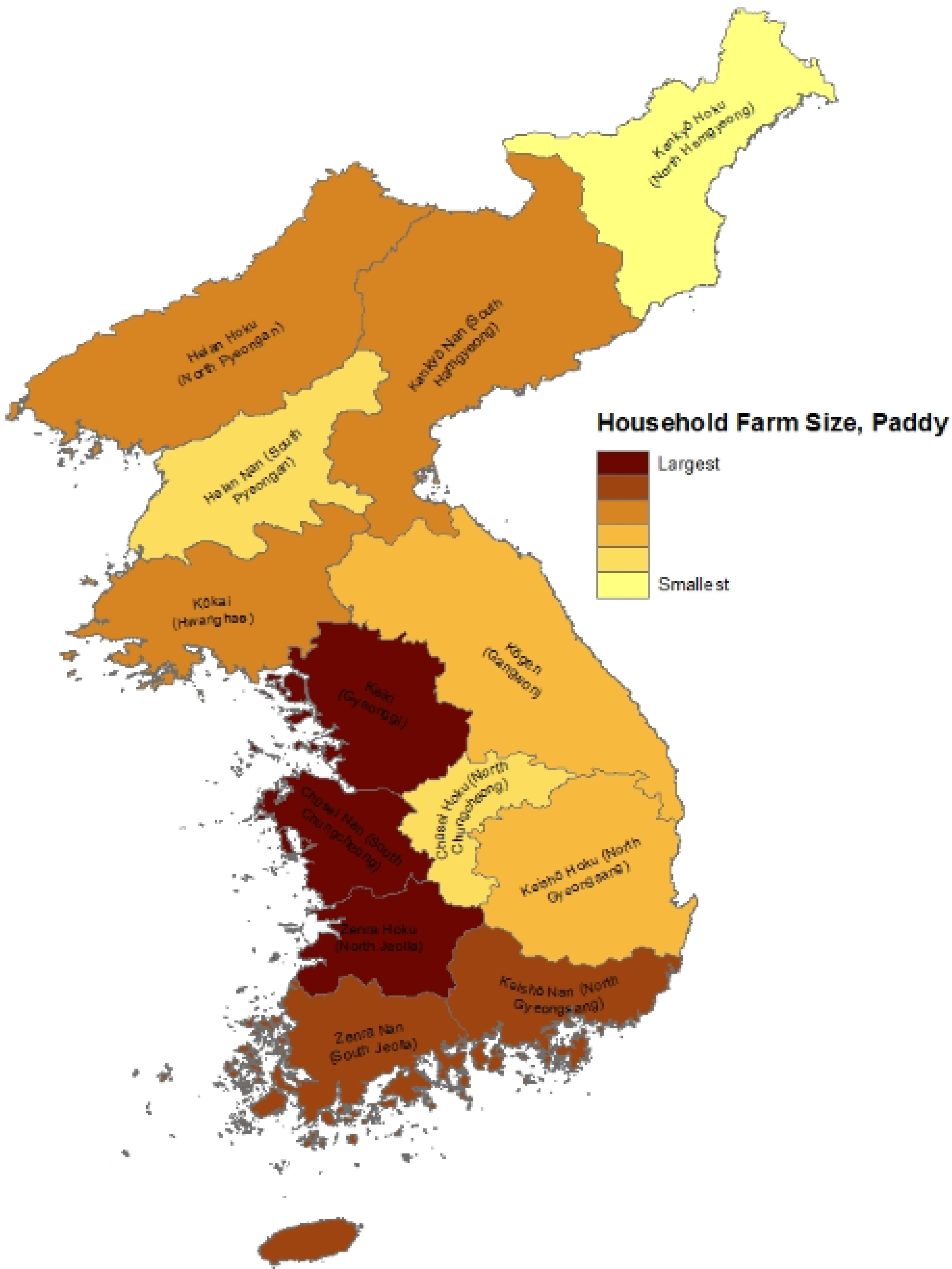
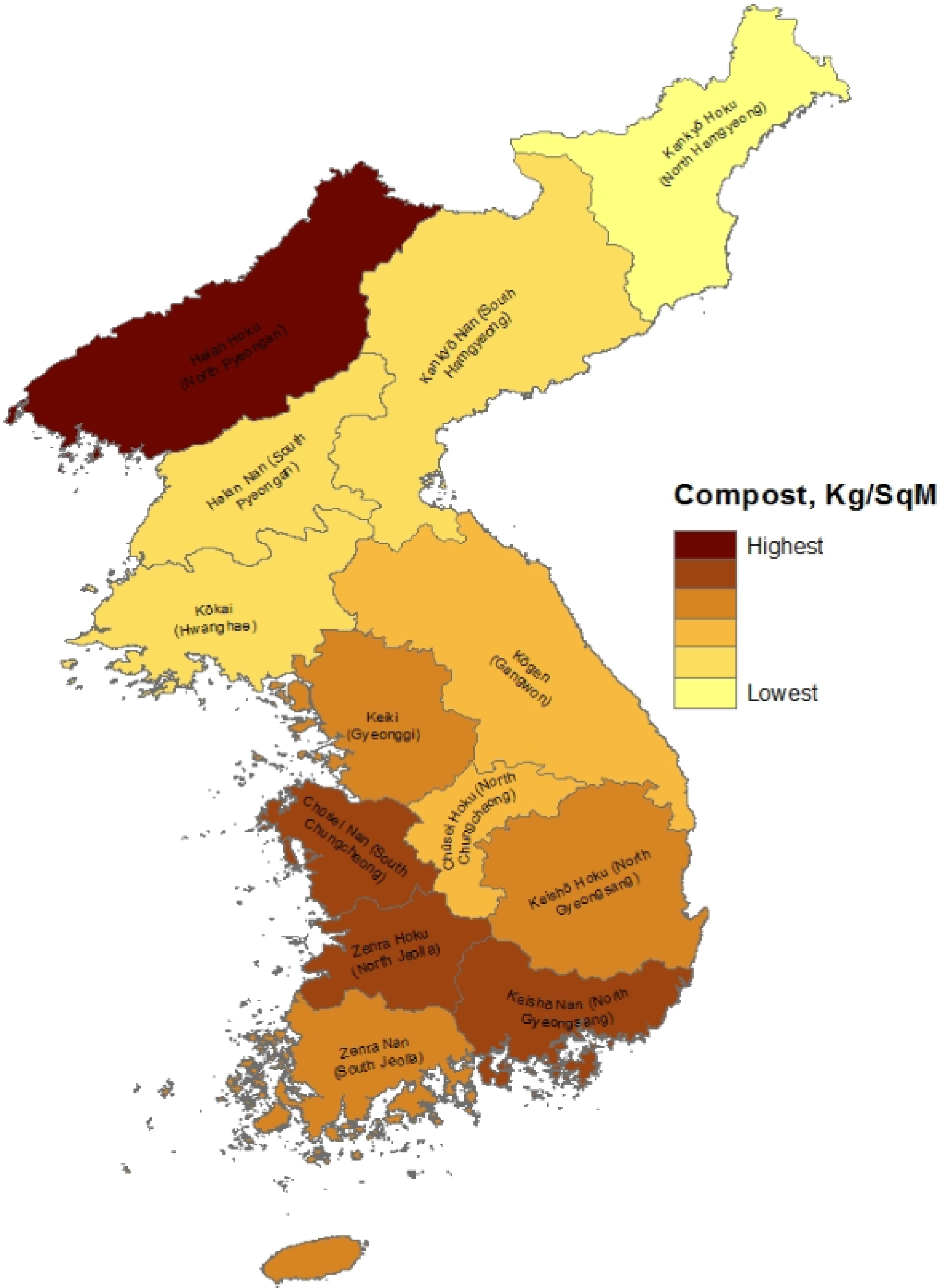
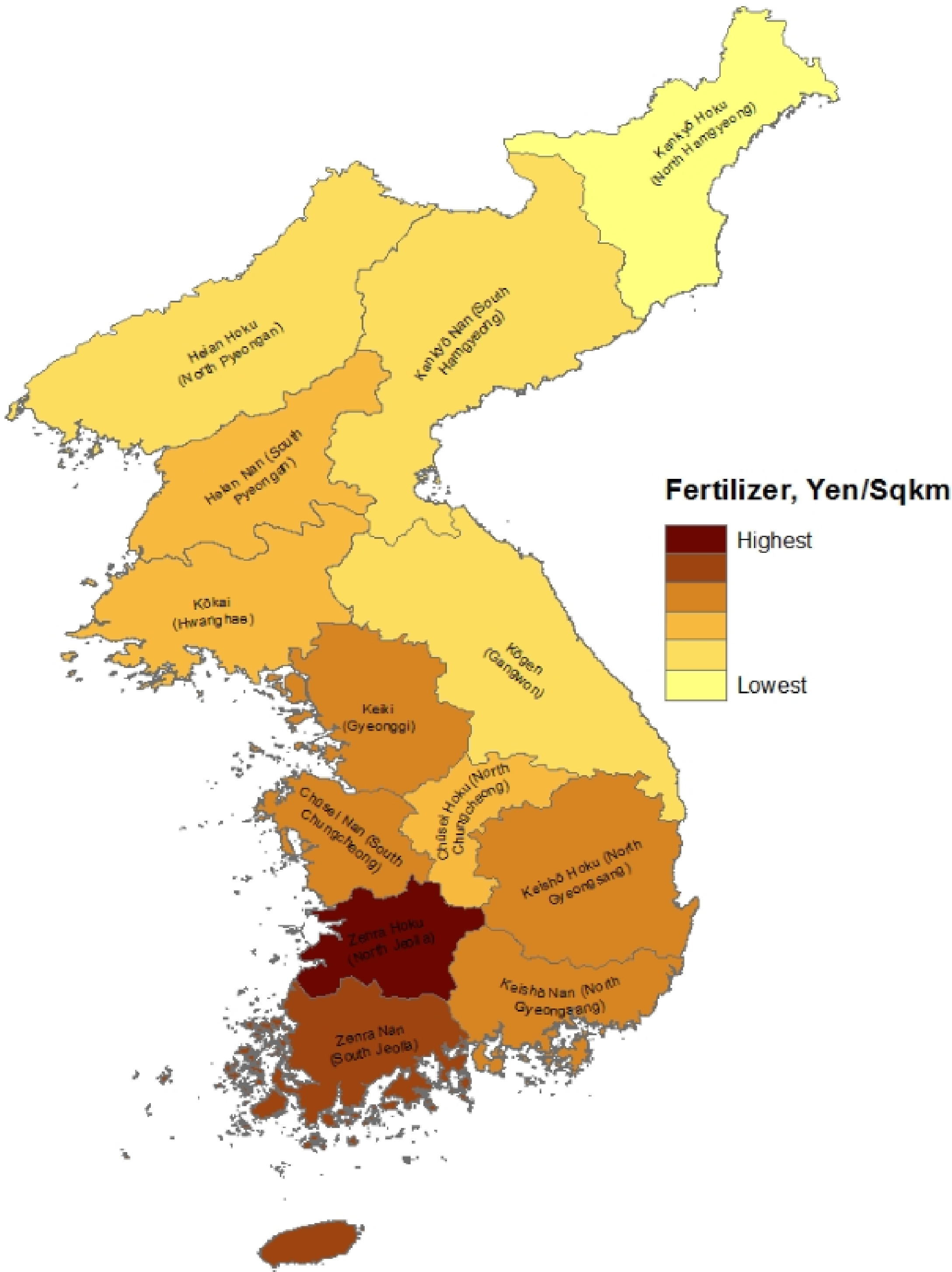


Figure 2: The inverse can be used to measure labor input.

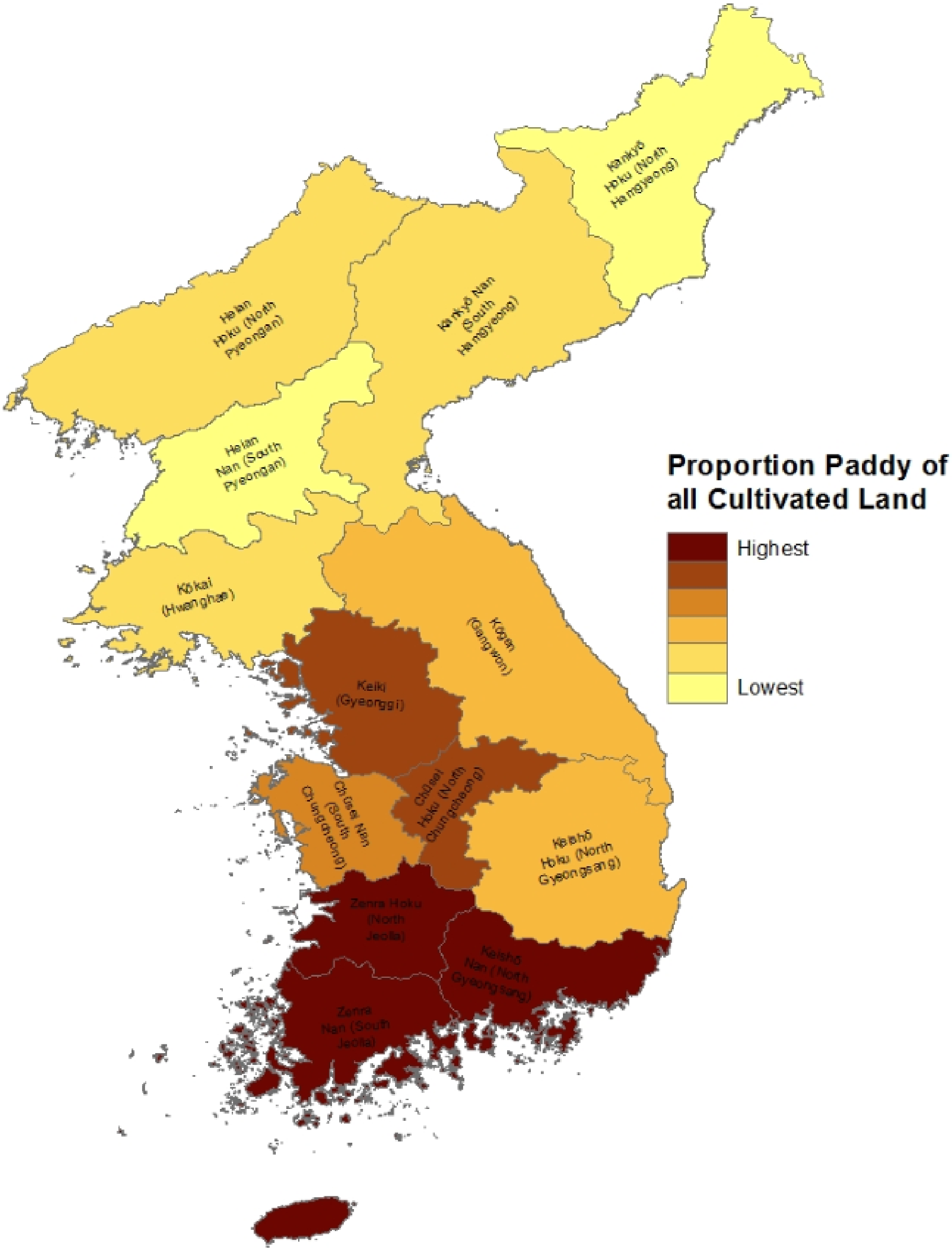
Map 2.3: "Self-Produced Fertilizer"



Map 2.4: Market Purchased Fertilizer



Map 2.5: Land Use Ratio



Map 2.6: Land Productivity (Rice)