

Dynamics of Household Assets and Income Shocks in the Long-run Process of Economic Development: The Case of Rural Pakistan

TAKASHI KUROSAKI*

This paper analyzes the dynamics of assets held by low-income households facing various types of income shocks in pre-independence and post-independence Pakistan. Focusing on the province of Khyber Pakhtunkhwa (formerly known as the North–West Frontier Province or NWFP), the paper first investigates long-run data at the district level beginning 1902. Results show that the population of livestock, the major asset of rural households, experienced a persistent decline after crop shocks due to droughts, but did not respond much to the Great Depression. In the post-independence period, crop agriculture continued to be vulnerable to natural disasters, although less substantially so, while the response of livestock to such shocks was indiscernible from district-level data. To examine microeconomic mechanisms underlying such asset dynamics, I analyze a panel dataset collected from approximately 300 households in three villages in the NWFP during the late 1990s. Results show that the dynamics of household landholding and livestock are associated with a single long-run equilibrium. When human capital is included, the dynamics curve changes its shape but this is not sufficiently nonlinear to produce statistically significant multiple equilibriums. The size of livestock holding was reduced in all villages hit by macroeconomic stagnation, while land depletion was reported only in a village with inferior access to markets. The patterns of asset dynamics established from historical and contemporary analyses are consistent with limited but improving access to consumption smoothing measures in the study region over the century.

Keywords: asset dynamics, natural disaster, buffer stock, poverty trap, Pakistan
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I. Introduction

Natural and man-made disasters, such as floods, droughts, earthquakes, depressions, hyperinflations, epidemics, etc., have affected the local and household

*Takashi Kurosaki is Professor, Institute of Economic Research, Hitotsubashi University. The author would like to thank two anonymous reviewers of this journal and participants at the Asian Development Review Conference on Development Issues in Asia held in Manila on 7 November 2012, particularly Natalie Chun, Charles Horioka, and Masahiro Kawai, for their productive comments on the earlier versions of this paper. The author is also grateful to S. Hirashima, Yukinobu Kitamura, Motoi Kusadokoro, Ken Miura, Tetsuji Okazaki, Hiroshi Sato, Masahiro Shoji, Yoshifumi Usami, and Koji Yamazaki for their useful comments on related papers. All remaining errors are the author's. This paper was funded by a JSPS Grant-in-Aid for Scientific Research-S (22223003).

economy worldwide and throughout modern history. Households in contemporary, low-income developing countries are particularly vulnerable for several reasons. First, their initial welfare levels are already close to the poverty line. Second, institutional arrangements to cope with disasters are lacking. Third, early warning systems are absent. Similar reasons are applicable to households in developed countries before these countries experienced modern economic growth. This is because of the presence of numerous symptoms associated with absolute poverty in such economies. To compound issues, according to the emergency events database (EM-DAT), there appears to be an increase in the number of natural disasters globally—from fewer than 100 per year in the mid-1970s to approximately 400 per year during the 2000s.¹

Thus, it is of critical importance to understand how households are affected by such disasters, how they recover from them, and how policies and market environments affect the dynamic process of recovery in the context of long-run economic development. Under incomplete markets, particularly with underdeveloped credit markets and missing insurance markets, poor households need to save as a precaution against downturn risk such as natural and man-made disasters. As a result, the asset choices of poor households may be excessively sensitive to risk avoidance, causing them to miss the opportunity to enhance expected income. In development economics, numerous theoretical and empirical studies focus on households' ability to cope with these shocks (Fafchamps 2003, Dercon 2005).

Furthermore, if the asset dynamics are highly nonlinear and hence associated with low and high long-run equilibriums, farmers may reduce consumption substantially after a disaster to preserve asset levels and avoid a low equilibrium (Carter and Barrett 2006). In an extreme case, households may find themselves in a poverty trap in the aftermath of disasters. These theoretical predictions have been investigated quantitatively for several developing countries, but there is no consensus regarding the shape of the asset dynamics curve.² Among recent studies, McKay and Perge (2011) tested for evidence of the existence of an asset-based poverty trap mechanism across seven panel datasets in developing countries, but they did not find evidence for this mechanism.

In contrast, the number of quantitative analyses on asset dynamics applied to historical contexts is small, mostly due to the nonavailability of suitable data. As an exception, the case of prewar Japanese farmers has been analyzed in several studies. For example, Kusadokoro, Maru, and Takashima (2012) analyzed asset accumulation behavior of farm households in rural Japan based on panel data from 1931 to 1941, the years of reconstruction following the Great Depression. They showed that

¹Available online: <http://www.emdat.be/natural-disasters-trends> (accessed on 20 October 2012). It is possible that the reported increase is partially due to an increased tendency to report—not necessarily an increase in the occurrence of—disasters.

²For example, see Naschold (2005); Adato, Carter, and May (2006); Carter et al. (2007); Mogue (2011); McKay and Perge (2011); and Miura, Kanno, and Sakurai (2012).

households accumulated liquid assets such as cash, quasi-money, livestock animals, and stocks in kind, suggesting the existence of a precautionary saving motive. Analyzing the same period but with a different data source, Fujie and Senda (2011) showed that farm households maintained the amount of arable land, increased non-farm labor supply, and decreased the use of fertilizer in response to the depression. They indicated that aggregate shocks from the Great Depression led to stagnation of agricultural growth in Japan. Both these studies applied microeconomic approaches similar to those reviewed in the previous paragraphs. Since the data requirement is high, application of these approaches to other historical cases is not straightforward.

This paper attempts to fill these gaps in the literature by combining empirical analyses using long-run historical data at the macro or semi-macro levels and contemporary data collected at the household level. The analysis focuses on the province of Khyber Pakhtunkhwa (formerly known as the North–West Frontier Province or the NWFP) of Pakistan.³ Using these different data sources, the paper addresses the question of how assets—particularly livestock, which is the core asset in the study area—respond to natural and man-made disasters.

Long-run historical (semi-) macro data, combined with data from historical reports prepared by the government, is employed to speculate on the microeconomic mechanism underlying asset dynamics in response to natural and man-made disasters. Contemporary household-level data are then used to shed light on the speculation from a different angle. The micro panel data, which form the basis for contemporary analysis, were collected from approximately 300 households in three villages during the late 1990s, the period associated with overall macroeconomic stagnation and not with major natural disasters.

Using household panel data, this paper estimates the shape of the asset dynamics curve using both nonparametric and parametric analyses. The parametric analysis additionally reveals how each type of asset responds to village-level and idiosyncratic shocks. Thus, the major contribution of this study is to demonstrate the complementarity of using both historical and contemporary analyses in understanding household vulnerability and resilience in the context of long-run economic development. To the best of the author's knowledge, there is no attempt in the literature to combine these two types of data in the manner adopted in this study.

The remainder of the paper is organized as follows. Section II reviews the related microeconomic literature and outlines the empirical methodology. Section III describes the rural NWFP economy with a focus on assets, agricultural technology, and livelihood. A descriptive analysis of long-run changes using district-level and

³Khyber Pakhtunkhwa is one of the four provinces that comprise Pakistan. In April 2010, the constitution of Pakistan was amended and the former NWFP renamed to Khyber Pakhtunkhwa. This paper identifies the province as NWFP since most of the data were taken under this name.

province-level historical data on crop production and livestock is then given in Section IV. Section V examines the two-period panel data collected during the late 1990s, while Section VI provides an interpretation combining the two types of analysis. Finally, conclusions are presented in Section VII.

II. Literature and Analytical Framework

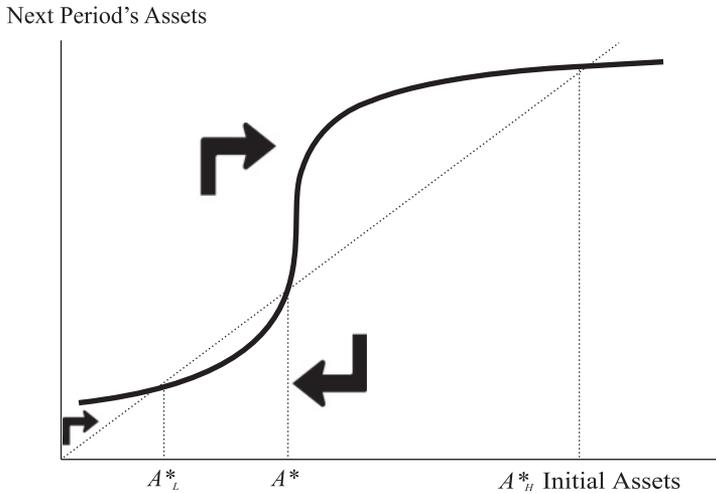
The empirical analysis in this paper is motivated by two strands of development economics literature. The first is the consumption smoothing literature, which focuses on low-income households' ability to cope with exogenous shocks (Fafchamps 2003, Dercon 2005). These studies have shown that poor households are likely to suffer not only from low levels of welfare on average but also from fluctuations in welfare due to limited coping ability. The inability of households to avoid declines in welfare can be called vulnerability. Currently, there is a substantial amount of literature on the measurement of vulnerability (Ligon and Schechter 2003; Dercon 2005; Kurosaki 2006; Dutta, Foster, and Mishra 2010). In developing countries, studies on household vulnerability found that the ability to avoid declines in welfare improves with an increase in the amount of assets that can be used as a buffer.

The other strand of literature relates to the "asset poverty trap" hypothesis by Carter and Barrett (2006). In the standard consumer theory of assets as a buffer (Deaton 1992), the next period's asset is a linear function of the current period's asset multiplied by a factor of one plus the real interest rate minus the depreciation rate. Under this condition, assets can be used to smooth consumption in response to income shocks. In this framework, a disaster that partially damages assets can be interpreted as an unexpected and transient increase in the depreciation rate.

In the context of low-income developing countries, however, asset dynamics may be nonlinear. Suppose that the expected value of an asset in the next period is an S-shaped function of the initial asset that has three intersections with a 45-degree line (Figure 1). The long-run dynamics of assets are then characterized by a middle and unstable equilibrium (called the Micawber threshold, A^* in Figure 1) and two stable equilibriums. The lower of the two stable equilibriums (A_L^* in Figure 1) corresponds to the poverty trap if the welfare level associated with this level of assets falls below or settles around the poverty line.

Given the existence of multiple equilibriums, Carter and Barrett (2006) argue that only those households well above the Micawber threshold can afford to use assets as a buffer to smooth consumption. They further contend that those households close to the Micawber threshold when hit by a negative income shock may rationally attempt to protect their assets to avoid falling into the asset poverty trap rather than sell these assets to smooth consumption. Therefore, we may observe asset smoothing behavior instead of consumption smoothing behavior in such cases.

Figure 1: The Asset Dynamics Curve



Source: Figure 4. Carter, Michael, and Christopher Barrett. 2006. The Economics of Poverty Traps and Persistent Poverty: An Asset-Based Approach. *Journal of Development Studies* 42(2): 178–199.

Although empirical support for the Micawber threshold is mixed, the concept is an attractive one.⁴ Even when the said threshold is not found, the shape of the asset dynamics curve and the location of the equilibria are informative for understanding household responses to shocks. Therefore, this paper tries to estimate asset dynamics curves for several types of assets using both nonparametric and parametric analyses. The parametric analysis additionally allows the identification of the impact of exogenous shocks on asset changes. Such shocks may include permanent and transient shocks on the one hand and aggregate and idiosyncratic shocks on the other.

This type of microeconomic analysis is usually conducted using micro panel data of households in developing countries in isolation from historical (semi-) macro data. Section V of this paper follows this tradition. However, by combining a statistical analysis with a historical one, we can benefit from complementarity. Hence, before presenting the microeconomic analysis, Section IV of this paper provides a descriptive analysis of the long-run changes using district-level and province-level data on livestock assets.

If the asset poverty trap hypothesis describes the historical data well, an exogenous shock that destroys the assets of majority of households should have a persistent impact. This persistence could possibly lead to an overall decline in assets in the district in the long run. On the other hand, if asset returns are linear and assets are used as a buffer, such a shock should have only a temporary impact and the economy should eventually revert to the initial trend. If the exogenous shock

⁴See studies listed in footnote 2.

destroys the assets of a majority of households, however, the reversion to initial trend may take time even under the buffer stock hypothesis such that empirically distinguishing the two hypotheses could be difficult.

The theoretical prediction regarding the impact of an exogenous shock that decreases the income of the majority of households but does not directly affect household assets also differs between the two hypotheses. Under the poverty trap hypothesis, the size of assets is not affected much by such a shock, while the size of assets decreases according to the buffer stock hypothesis. When the impact of such an exogenous shock on household income is heterogeneous, however, the shock may not affect the aggregate asset level even under the buffer stock hypothesis as effects cancel out. As a result, empirically distinguishing the two hypotheses could likewise be difficult.

Meanwhile, whether a specific type of asset, such as livestock, is used more as a buffer or as productive capital compared to other types of assets depends on the availability of other consumption smoothing measures and agricultural technology (e.g., the substitutability of draft animals in farm production). The next section thus describes the means of livelihood in the rural NWFP economy, with its focus on assets and agricultural technology.

III. The Study Area

Economic development in South Asia is characterized by moderate success in economic growth and substantial failure in human development such as basic health, education, and gender equality (Drèze and Sen 1995). This characteristic is most apparent in the NWFP. Furthermore, the scope for economic growth based on crop agriculture is limited since the province is land-scarce and crop production is riskier than in other parts of Pakistan due to low development of irrigation. These additional hardships make the NWFP case study an interesting one in terms of investigating the relationship between asset dynamics and disasters.

A. Rural Livelihood and the Role of Livestock

The NWFP as a whole is a rural province. According to the population census conducted in 1998, 83% of its population lived in rural areas (Government of Pakistan 2012).⁵ Until the 1980s, a majority of rural residents were engaged in agriculture, both crop cultivation and animal husbandry. However, since the late 1980s, employment in the nonagricultural sector has been growing.

Two types of nonagricultural activities are noteworthy: short-term migration (both domestic and foreign) and rural nonagricultural activities in villages. In both

⁵The 1998 population census is the latest conducted by the Government of Pakistan.

types, semi-skilled work such as transport and construction work dominates in terms of employment creation. The availability of skilled or professional jobs has been limited in the province, although it has been increasing gradually in recent years. Furthermore, the average household size is larger than in other parts of Pakistan, partly reflecting the norm of the Pakhtun—the ethnic majority of people in the NWFP—who highly respect family-based reciprocity and bravery in defending their land, property, family, and women from incursions, etc. (Ahmed 1980).

The major crops in the NWFP are wheat in the *rabi* (winter) season and maize in the *kharif* (monsoon) season. Both these crops are cultivated as staple food, although large farmers tend to sell the surplus to the market. Sugarcane is the most important cash crop. Fodder crops to feed livestock animals also occupy a significant share of cropped land in both *kharif* and *rabi* seasons.

A particular mention must be made of the role of livestock. Most farmers in the NWFP are engaged in mixed farming, combining livestock raising and crop cultivation on a single farm. Large livestock animals include cows and female buffaloes for milk. Bullocks were once an important productive asset used for plowing and transportation. However, tractors gradually replaced draft animals, thereby decreasing the role of livestock as draft animals.⁶ As shown in the next section, the livestock portfolio in the NWFP has been changing from draft to milk animals. Small livestock animals, such as goats, sheep, and poultry, are common means of saving.

This implies several interactions between crop farming and livestock husbandry in the study area (Kurosaki 1995). The direct interactions can be explained in the following manner: Fodder crops and dry fodder (e.g., grain straws) are fed to animals, animal excrements are processed into farmyard manure used in crop cultivation, draft animals are used in plowing and crop transportation, while crop rotations including leguminous fodder crops improve the soil fertility.

Meanwhile, the indirect interactions between the livestock sector and crop farming through the household economy can be described as follows: Milk animals provide milk for consumption and cash from selling surplus milk, family labor is utilized throughout the year for taking care of animals, and livestock serve as a liquid form of asset that can be used as a buffer in a bad year. In the following sections, I analyze how these complicated interactions result in a reduced-form relation between asset dynamics and disasters (identifying each of these interactions, however, is beyond the scope of this paper).

Direct interactions mentioned above are relevant only for households that operate farmland for crop cultivation (i.e., “farm households”).⁷ However, indirect interactions are important for nonfarm households as well. Income sources of

⁶As the tractor service rental market is well developed, the majority of farmers who use tractors for land preparation do not own a tractor.

⁷Because of a social distinction between land-operating households and other households in Pakistan (Hirashima 2008), I employ the standard categorization in which such households are called “farm households.”

nonfarm households could include livestock activities, nonagricultural activities, net rental receipt, transfers, etc.

This implies that in the study area, agricultural assets (land and livestock) are the key assets that constitute rural livelihood. It also implies that human capital (size of labor force, education, etc.) and transport and agricultural equipment (e.g., tractors and vehicles) are also gaining importance. Hence, all these assets were included in the microeconomic analysis. Because of data availability, the historical analysis focuses on livestock animals since they were—and are—the most important asset supporting the livelihood of both farm and nonfarm households.

B. The NWFP during the Colonial Period and the Change after Independence

In October 1901, the British government carved out the NWFP from Punjab as a separate province. The word “frontier” in the name implied the frontier against Russian influence. As one of the British provinces of the Indian Empire, the NWFP was divided into districts for the purpose of its administration. During the colonial period, there were five districts (Hazara, Peshawar, Kohat, Bannu, and Dera Ismail Khan) until 1937, when a new district of Mardan was carved out of Peshawar District.

The property right of land was established under the British rule of the NWFP, where ownership was given to cultivators, as was the case in Punjab (Khalid 1998). The cultivators included village-based landlords who operated a part of their land and rented out the remainder. During the colonial period, social development such as education was highly limited in the province, while infrastructure development such as roads and irrigation canals progressed gradually. The British rule respected the local norm of self-governance in the NWFP, particularly the institution called *jirga*—an assembly of elders taking decisions by consensus (Ahmed 1980)—as long as such decisions did not violate British rulings.

Agricultural innovation such as the introduction of chemical fertilizers and improved methods of cultivation was facilitated in the province, although at a slower pace than in the post-independence period. For example, systematic agricultural research began in the NWFP in 1908 at a government research institute in Tarnab, Peshawar District. Furthermore, the colonial government introduced a modern credit facility for farmers called *taccavi* loans. However, the credit facility was not utilized by the majority of farmers due to limited access and high requirements of land collateral, and informal credit prevailed in villages (Malik 1999).

Pakistan and India obtained independence from the British in August 1947 (the so-called Partition of the Indian Subcontinent). The NWFP now belonged to the new state of Pakistan. The basic administrative structure remained intact and the list of six NWFP districts remained the same until 1970. However, since then, the

subdivision of districts has continued due to the growth in population. At the end of 2012, there were 25 districts in Khyber Pakhtunkhwa.⁸

After independence, the pace of public investment in infrastructure and agricultural innovation accelerated. At the time of Partition, the percentage of cultivated area with irrigation was 38% in the NWFP. After 50 years, the corresponding figure grew to 50%. The Green Revolution technology for wheat was introduced to the province in the late 1960s. However, land property institutions remained more or less the same. Laws and regulations related to land reforms were enacted to put ceilings on land holdings, but they did not have much impact on the province as the number of large landlords had been small (Khalid 1998). Furthermore, in the post-independence period, government credit for agricultural production was expanded—for example, the Agricultural Development Bank of Pakistan was established in 1961. Nevertheless, the dependence of rural households on informal credit continued, partly because of the Islamic norm of banning interest payments and partly due to the limited resources of the public sector (Malik 1999).

IV. District-level and Province-level Analysis of Crop Production and Livestock

This section conducts long-run historical analysis using district-level and province-level data on crop production and livestock. Province-level data indicates data aggregated at the NWFP, regarded as the macro level in this study. Each district is viewed as the semi-macro level. The analysis in this section is descriptive in nature. It first examines the time series plots for crop production and livestock and extracts statements from government reports. It then interprets the descriptive results based on theoretical predictions summarized in Section II.

A. Data

Considering the changes in district borders described in Section III, this study adopted the following geographical demarcation. For the colonial period, the paper compiled a balanced panel dataset of five districts (after 1937, data for Peshawar and Mardan were merged to form the initial district of Peshawar). For the post-colonial period, it compiled a balanced panel dataset of six districts (Hazara, Peshawar, Mardan, Kohat, Bannu, and Dera Ismail Khan) that correspond to the district borders at the time of Partition.

Original data sources and the data compilation procedure were the same as those adopted in the author's ongoing attempt to construct long-term agricultural statistics for South Asia under the Asian Historical Statistics Project at Hitotsubashi

⁸The household surveys analyzed in Section V were conducted in the current district of Peshawar.

University, Tokyo (Kurosaki 2003 and 2011). For the colonial period, various issues of *Season and Crop Reports* published by the NWFP Government, Peshawar, were used as the main data source. The first issue was published for the agricultural year 1902/1903 and the last for the agricultural year of 1944/1945.⁹ Each *Season and Crop Report* presents an overview for the year with regard to rainfall, agriculture, and the rural economy, with statistical tables at the district level.¹⁰

From this source, the paper compiled district-level and province-level annual data of areas under crops and output of major crops.¹¹ The same source reports statistical tables for the district-level agricultural stock (livestock, plows, etc.) based on quinquennial livestock census. Thus, the paper obtained livestock information for the years 1903, 1904, 1909, 1914, 1920, 1925, 1930, 1935, 1940, and 1945. In compiling the dataset, typographical errors were corrected, and definitional changes were adjusted to improve comparability across years.

The data source for the post-colonial period is the official statistics compiled by the Government of Pakistan (*Crops Area Production by Districts* and *Pakistan Livestock Census*, with the names differing slightly depending on the publication year). Regarding the district-level crop data, the first year for which data had been made available was 1947/1948. Therefore, a data gap of 2 years exists between the pre-1947 and post-1947 periods. Compared to the colonial period, district-level livestock data became less frequent after the Partition—there were only six observations taken from the Agricultural Census (1960 and 1972) and the Livestock Census (1976, 1986, 1996, and 2006).

Three types of crop variables are investigated in this paper to infer the shocks that occurred in the crop sector. Since the area planted to major crops declines when monsoon rainfall is less than normal, the first type includes the total area sown with *kharif* crops (*kharif_a*), *rabi* crops (*rabi_a*), and wheat (*wheat_a*) for the pre-independence period; and further, the area sown with maize (*maize_a*) and wheat (*wheat_a*) for the post-independence period.¹² As natural disasters such as droughts, floods, and hailstorms affect yield per acre, the second type includes per-acre yield of wheat (*wheat_y*) and maize (*maize_y*). Since such information is not available for the early part of the colonial period, this investigation is limited to the post-independence period. Meanwhile, the third type includes the total area of failed crops (*fail_a*) as a direct measure of crop production shocks. Since the information

⁹An agricultural year begins in July and ends on 30 June the following year. The year 1902/1903, for instance, covers *kharif* crops planted in the mid-1902 and harvested in the later months of 1902, *rabi* crops planted in late 1902 and harvested in April–June 1903, and sugarcane harvested in late 1902 to early 1903. In figures with limited space, this period is represented as “1903.” In Pakistan, a fiscal year constitutes the same period—i.e., from 1 July to 30 June the next year.

¹⁰The sections in *Season and Crop Reports* on “agricultural stock,” “agricultural deterioration,” and “condition of agricultural population” were particularly useful for understanding shocks that occurred during the year. Unfortunately, comparable information was not available for the post-colonial period.

¹¹The information on the output of major crops became available from 1906/1907 onward.

¹²The reason for the difference is the unreliability of maize data in the pre-independence period and the inconsistency in reporting the total *kharif* area in the post-independence period.

on *fail_a* is not available for the post-independence period reflecting negligible areas under this category, the investigation only applies to the pre-independence period.

Changes in these crop variables are then associated with changes in the population of livestock animals, which are the major assets of rural households in the NWFP. The livestock variables analyzed include the number of adult bulls and bullocks (*bull*), adult cows (*cow*), and adult she-buffaloes (*buf_f*).¹³

B. Impacts of Disasters before Independence

Figure 2 plots the time series of crop production and livestock population for the colonial period. Panel A shows the result for the province. First, there was no long-run trend in crop production and livestock population. This is in sharp contrast to the Punjab area of Pakistan before Partition where there had been sustained agricultural growth (Kurosaki 2003). Since there had been population growth in the NWFP during the first half of the century, the relative stagnation of agriculture in this area implies that its dependence on agriculture in Punjab for food increased.¹⁴ Second, crop production fluctuated substantially from year to year. Third, area fluctuations in *kharif* crops and in wheat were not synchronized. In certain years, only one of the two experienced a fall while the other experienced a rise, while in other years, both of them moved in the same direction. Fourth, livestock population experienced an increase until 1914, then declined in two subsequent censuses in 1920 and 1925, after which the population remained stable.

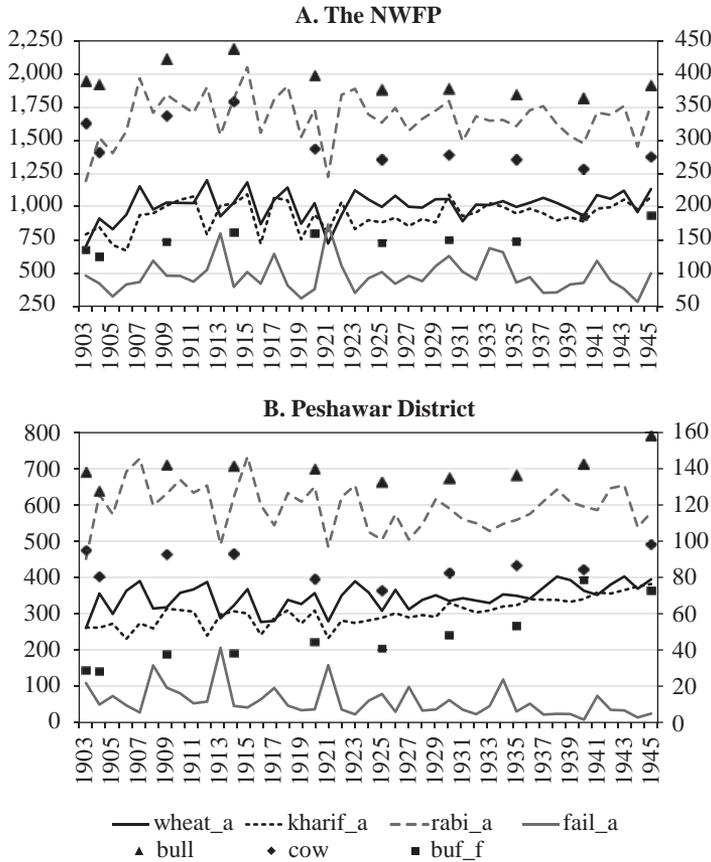
The figure clearly suggests that the agricultural year 1920/1921 was a particularly bad year, followed by a substantial decline in the livestock population. From 1920 to 1925, the population of adult bulls and bullocks in the province declined by 5.4%, adult cows by 5.3%, and adult she-buffaloes by 9.3%.

The time series plot for Peshawar District (panel B, Figure 2) is similar to that for the entire province. Of particular importance had been the decline in the livestock population from 1920 to 1925 and the substantial crop production shock in 1920/1921. The similarity in the time series plot is expected since the colonial district of Peshawar was the most important district in the NWFP in terms of agriculture, accounting for approximately one-third of the cropped area in the entire province, and the extent of spatial specialization was weak due to lack of infrastructure and low level of urbanization. On the other hand, panel B differed noticeably from panel A in terms of trends after the mid-1920s. Bottoming in the years around 1925, cropped areas and the livestock population in Peshawar District grew, albeit

¹³Since a more detailed classification of animals is available for the period after Partition and the distinction among animals according to purpose quite important in the study area, the paper considers only adult bullocks used as *draft animals*, adult cows *in milk*, and adult she-buffaloes *in milk* after Partition. Therefore, the absolute level of livestock population is not comparable between pre-independence and post-independence periods.

¹⁴The population of the NWFP districts analyzed in this paper grew from 2.04 million in the 1901 census to 3.25 million in the 1951 census. The corresponding figure in the 1998 census was 13.48 million.

Figure 2: Crop Production and Livestock in the NWFP before Partition, 1903–1945



NWFP = North–West Frontier Province.

Note: (1) Crop variables (wheat_a, kharif_a, rabi_a, and fail_a) are plotted on the left axis (in 1,000 acres).

(2) Livestock numbers (bull, cow, and buf_f) are plotted on the right axis (in 1,000 heads). (3) Peshawar

District corresponds to the district borders until 1937. It comprises the current districts of Peshawar, Charsadda, Nowshera, Mardan, and Swabi.

Source: Author’s representations using the dataset described in the text.

gradually, until the year of independence, while the crop failure rate declined. This could be attributed to agricultural innovation facilitated by systematic agricultural research.

From *Season and Crop Reports*, several statements are extracted below regarding agriculture in the NWFP. For example, with regard to the livestock decline in 1920, the publication stated that the “The recent cattle census [February 1920] came at rather an unfortunate time following, as it did, a year of war and frontier disturbances, and also a severe season of drought (in the barani [rainfed] tracts) in 1918. Widespread epidemics of cattle disease followed which the already greatly

debilitated stock was unable to withstand.”¹⁵ Regarding the decline in livestock in 1925, it was stated that “Bulls, cows and cow-buffaloes decreased by 6, 2 and 9 per cent, respectively. The drought of 1920–22 and consequent scarcity of fodder, cattle diseases and plague, which prevailed more or less in all districts during the period under report, were mainly responsible for this.”¹⁶ In sharp contrast, I find no such statements for the other years.

With regard to the interaction between crop and livestock sectors, notable descriptions in the NWFP *Season and Crop Reports* include the following:

Two poor harvests (except in the Hazara District) combined with a very serious epidemic in the autumn [Spanish flu] have occasioned a passing check to agricultural prosperity.¹⁷

The abnormally severe drought experienced during the year under report has been a great trial to the agricultural population who have had to dispose of their plough cattle in many tracts in order to raise money to buy food. Seed stocks have mostly been consumed as food . . . The condition of the agricultural population was generally very unsatisfactory throughout the Province as both the Kharif and Rabi harvests were poor and the supply of water and fodder was insufficient on account of prolonged drought.¹⁸

There were also statements regarding natural disasters other than droughts, for example, regarding hailstorms and floods. With regard to floods, all the statements found in the reports are related to local floods that affected only a particular portion within a district.¹⁹ This is in sharp contrast to the nationwide floods that hit Pakistan in July–August 2010 (Kurosaki and Khan 2011). Moreover, no statement was found in which the livestock population change was associated with crop shocks due to hailstorms and floods.

With regard to the Great Depression, the most detailed description was given in the 1930/1931 edition of the publication (p. 9): “The fall in prices and the resulting contraction in the credit of the cultivator, the repression in trade, and the shortage of money—all aspects of the same phenomenon—have caused the greatest inconvenience to the agricultural community in the Peshawar District where money has to be raised to pay cash rents and Government dues particularly for water-rate. The result is that very large arrears are outstanding in spite of the general remissions

¹⁵Page 5 of the 1919/1920 edition, with brackets added by the author.

¹⁶Page 7 of the 1924/1925 edition.

¹⁷Page 5 of the 1918/1919 edition, with brackets added by the author.

¹⁸Pages 5 to 6 of the 1920/1921 edition.

¹⁹See page 2 of the 1903/1904 edition, page 2 of the 1908/1909 edition, pages 1 to 2 for the 1910/1911 edition, and page 6 of the 1921/1922 edition.

and reductions designed to counter the fall in prices.” Similar but shorter statements were found in the report in the years that followed, until 1938/1939.

However, it is rather difficult to find an impact of the depression on either crops or livestock in Figure 2. The absence of an impact on crops could be due to the difficulty in clearly designating the year (or years) of the disaster or to the indirect nature of the disaster’s impact on crop production.

C. Crop Production and Livestock Population after Independence

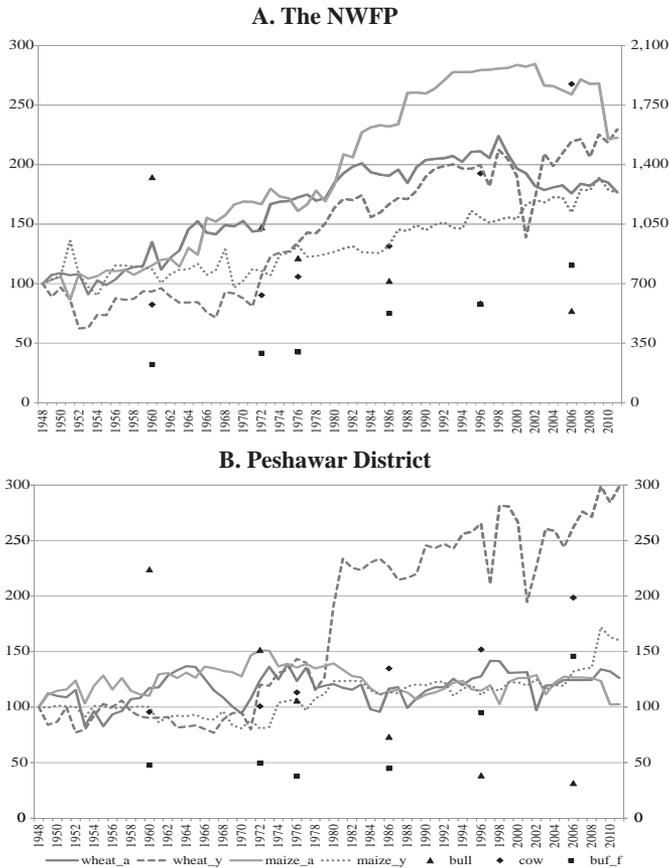
Figure 3 plots the time series of areas and per-acre yield of wheat and maize. It also plots the livestock population found in six agricultural/livestock censuses after independence. Panel A presents the result for the province. First, all four time series for crops show sustained and continuous growth. This is similar to the case of Punjab Province after Partition (Kurosaki 2003).

Second, crop production seemingly fluctuated from year to year. However, significant reductions were less frequently observed after Partition than before Partition except for a sudden drop in per-acre yield of wheat in 2000/2001. In 2010/2011, when unprecedented floods hit Pakistan (Kurosaki and Khan 2011), maize yield was adversely affected (direct effect of floods), but maize area was not, as the crop had already been planted when floods came. Moreover, wheat area was also adversely affected due to farmers’ preoccupation with reconstruction and floods’ destruction of irrigation and other facilities, but wheat yield improved since the floods fertilized the soil. Overall, the impact of the 2010 floods does not seem substantial from the macro viewpoint regarding crops.

Third, two trends are evident in livestock population: a continuous decrease in the number of bullocks and a continuous increase in the number of cows and she-buffaloes in milk. As data are available only for 6 years with 10-year intervals on average, this paper could not examine how the livestock population responded to crop shocks in the short to medium run. However, the figure clearly shows that there has been no discernible instance of livestock damage due to crop shocks that persisted for over a decade.

The time series plot for Peshawar District (panel B, Figure 3) appears rather different from that for the entire province, the major dissimilarity being the sustained growth observed only in the per-acre yield of wheat. The area under wheat and under maize and the per-acre yield of maize have all been stagnant since the early 1970s. There was growth in spatial specialization during the post-independence period owing to the development of infrastructure and cities. As a result, agriculture in Peshawar underwent a transformation to include high-value activities such as horticulture, plant nursery, and livestock husbandry. Because of this, the shape of the time series plot in Peshawar District after independence deviates from that at the provincial level. On the other hand, the improvement in per-acre yield of wheat in the late 1970s was substantial (the late arrival of the Green Revolution).

Figure 3: Crop Production in the NWFP after Partition, 1948–2011



NWFP = North–West Frontier Province.

Note: (1) Crop variables (wheat_a, wheat_y, maize_a, and maize_y) are plotted on the left axis (unit: index with 1948 = 100. The absolute level in 1948 for the four variables are 410 (1000 ha), 695 (kg/ha), 190 (1000 ha), 995 (kg/ha) for the NWFP and 68 (1000 ha), 828 (kg/ha), 36 (1000 ha), 1550 (kg/ha) for Peshawar. (2) Livestock numbers (bull, cow, and buf_f) are plotted on the right axis (unit: 1,000 heads). (3) Peshawar District corresponds to the district borders in 1948. It comprises the current districts of Peshawar, Charsadda, and Nowshera.

Source: Author’s representations using the dataset described in the text.

Regarding the livestock population, trends similar to those for the NWFP are observed in Peshawar District, but with steeper slopes for the decrease in the number of bullocks. The diversification toward milk animals in Peshawar District thus occurred at a faster pace than at the provincial level.

D. Interpreting the Historical Patterns in Assets from the Viewpoint of Microeconomics

The descriptive analysis presented above showed that agriculture in the NWFP, particularly before Partition, had been affected by several natural disasters, mostly

droughts. This led to a decline in the livestock population that persisted for over 5 years. On the other hand, such persistent declines in the livestock population were not observed in district-level data after independence. This indicates that during the post-1947 period, persistent declines in the livestock population due to such shocks had been avoided by the province. In this subsection, I provide a speculative interpretation of this contrast based on the theoretical predictions summarized in Section II.

The pre-independence observations could be consistent with both the asset poverty trap hypothesis and the buffer stock hypothesis. The descriptive analysis showed that in 1920/1921, natural disasters damaged the livestock population (which already suffered from small disasters in the preceding years) so intensively that the livestock population level did not recover to the 1920 level even in 1925. The persistence of the damage could be more consistent with predictions under the poverty trap hypothesis than under the buffer stock hypothesis. However, as the droughts killed a number of animals directly, the recovery to the initial trend could have taken a long time even under the buffer stock hypothesis. The statement from the 1920/1921 *Season and Crops Report* quoted above (“agricultural population . . . had to dispose of their plough cattle in many tracts in order to raise money to buy food”) also supports the view that livestock had been used as a buffer.

The descriptive analysis also showed that the Great Depression failed to affect the trends in livestock population. On one hand, this could be interpreted under the poverty trap hypothesis as the absence of a direct impact of the shocks on assets. On the other, this could be interpreted under the buffer stock hypothesis as income shocks being heterogeneous among households, where some farmers sold livestock to cope with the negative shocks while others purchased them, resulting in nonresponse of the livestock population at the district level.

The post-independence observations seem more consistent with the buffer stock hypothesis than with the poverty trap hypothesis. The descriptive analysis showed the absence of persistent declines in the livestock population despite several instances of crop shocks that should have reduced the livestock population directly in the short run. If asset returns are almost linear and the assets are used as a buffer, such a shock would have only a temporary impact and the economy would revert quickly to the initial trend. This theoretical prediction is consistent with Figure 3, as it does not show any disturbance in the trends in the livestock population.

However, this observation could also be consistent with the poverty trap hypothesis with nonlinear asset returns if farmers had sufficiently diversified portfolios so that several instances of crop shocks shown in Figure 3 did not actually reduce the livestock population substantially. Unfortunately, the unavailability of more frequent and/or more disaggregated data on the livestock population does not allow us to explore this possibility further.

The historical description of the study areas in Section III could provide additional support to the interpretation that post-independence livestock dynamics

seem more consistent with the buffer stock hypothesis. As shown in the section, the post-independence period was characterized by better infrastructure, greater availability of formal credit in villages, and agricultural technology where draft animals were substitutable with tractor services. My speculation is that the combination of changing agricultural technology and better opportunities for villagers to spread risk across and within villages had been responsible for the contrast between pre-independence and post-independence periods.

V. Household-level Asset Dynamics in 1996–1999

Although suggestive, the empirical results given in the previous section were at the aggregate level, and hence not indicative of asset dynamics at the household level. The speculations discussed above need to be supplemented by micro-level evidence. Therefore, in this section, the dynamics are examined using a detailed panel dataset of households collected from three villages in Peshawar District during the late 1990s.

A. Data

The panel dataset was compiled from the baseline survey conducted in the fiscal year 1996/1997 and the resurvey conducted 3 years later (Kurosaki 2006, Kurosaki and Khan 2006).²⁰ The baseline survey covered 355 households randomly chosen from three villages in the Peshawar District. Sample villages were purposely chosen so that they would be similar in terms of size, historical background, and tenancy structure, but different in terms of irrigation level and access to the main market (Peshawar, the provincial capital of NWFP). The intention for this method of choosing villages was to infer long-run development implications by comparing the three villages.

Using a detailed questionnaire, information was collected on household roster, agricultural production (corresponding to the agricultural year of 1995/1996), employment, assets, etc. in the baseline survey (referred to as the 1996 survey). The resurvey, conducted 3 years after, collected crop information for the agricultural year 1998/1999 (the 1999 survey). Out of 355 households surveyed in 1996, 304 households were resurveyed successfully. Among those resurveyed, three were divided into multiple households, while two had incomplete information on consumption. Therefore, a balanced panel dataset of 299 households with two periods

²⁰Existing papers using the same dataset, including Kurosaki (2006) and Kurosaki and Khan (2006), did not analyze the dynamics of assets.

Table 1. Characteristics of the Sample Households in the 1996–1999 Panel Survey, the NWFP of Pakistan

Variable	Village A	Village B	Village C
1. Village Characteristics			
Agriculture	Rainfed	Rain/Irrigated	Irrigated
Distance to main roads (km)	10	4	1
Population (1998 Census)	2,858	3,831	7,575
Adult literacy rates in % (1998 Census)	25.8	19.9	37.5
2. Characteristics of Households in the Panel			
Number of households	83	111	105
Average of initial characteristics in the 1996 survey ^a			
Household size	10.75	8.41	8.95
Literacy rate of working age adults (%)	16.8	17.6	31.3
Average farmland owned (acres)	5.51	1.28	1.43
Per capita value of farmland asset (PRs100,000) ^{b,c}			
1996 survey	0.475	0.804	0.376
1999 survey	0.306	0.417	0.394
Per capita value of livestock asset (PRs1,000) ^{b,c}			
1996 survey	1.525	1.181	1.884
1999 survey	1.087	0.727	1.042
Per capita income (poverty line units) ^{b,d}			
1996 survey	1.074	1.278	1.861
1999 survey	0.856	0.953	1.225
Per capita consumption (poverty line units) ^{b,d}			
1996 survey	0.743	0.868	1.110
1999 survey	0.773	0.828	1.148

PRs = Pakistan rupees.

^aAverages over all sample households.

^bAverages based on individuals with the number of household members as weights.

^cIn 1996 prices, adjusted for inflation.

^dThe same poverty line adjusted for inflation was used for each period (1996 and 1999) for both income and consumption and for all villages to convert per capita income (consumption) into poverty line units.

Source: Author's computations based on 1996–1999 panel data described in the text.

was utilized for the analysis.²¹ After the 1999 survey, I revisited the villages several times, observing changes in a casual manner.

Table 1 summarizes the characteristics of sample villages and households. Village A is rainfed and located at a considerable distance from the main roads, serving as an example of the least developed villages. Village C is fully irrigated and located close to a national highway, serving as an example of the most developed

²¹To infer the potential bias due to attrition, I first regressed the attrition dummy on village dummies and household initial characteristics. The probit result shows that attrition occurred more among households living in Village A than in Villages B and C and among households whose heads were more educated. Other household attributes were not statistically significant. As the probit result shows that attrition was not completely random on observables, I conducted a test developed by Beckett et al. (1988). The welfare ratio in the first survey was regressed on the baseline characteristics of households, an attrition dummy, and the attrition dummy interacted with the other explanatory variables. None of the coefficients corresponding to an additional slope for the attrition households was significant and the joint significance test did not reject the null hypothesis at the 20% level. Therefore, there is unlikely to be a significant attrition bias in the estimates provided in this paper. Detailed results are available on request.

villages. Village B falls in between Villages A and C. Average household sizes are larger in Village A than in Villages B and C, thereby reflecting the stronger prevalence of an extended family system in the village. Average landholding sizes in acres are also larger in Village A than in Villages B and C. Since the productivity of purely rainfed land is substantially lower than that of irrigated land, effective landholding sizes are comparable among the three villages as shown in the statistics for per capita values of land assets in Table 1.

Household income and consumption were calculated by including the imputed values of nonmarketed transactions. Average income and consumption per capita were lowest in Village A and highest in Village C, in line with the survey objective of selecting villages with different levels of economic development. In terms of education, Village C had higher achievement levels than the other two villages. As shown in Kurosaki and Hussain (1999), nonagricultural income constituted a larger share in the total household income than agricultural income in 1996, regardless of the land operation status of households in all three villages. In all three villages, nonagricultural, unskilled wage work accounted for approximately one-third of household income. Among other nonagricultural sources, migration income was important in Village A, while self-employed business was important in Village C. Self-employment income from livestock activities accounted for approximately 10% of household income, including nonfarm households.

As shown in Table 1, the average household income per capita declined substantially from 1996 to 1999. This was mostly due to the macroeconomic stagnation of Pakistan's economy associated with political turmoil, which affected the NWFP's economy most severely among the four provinces. As shown in Figure 3 in the previous section, there was no province-wide agricultural shock that affected both the *rabi* and *kharif* crops during 1996–1999. Therefore, the analysis in this section is intended to capture the asset dynamics in years with a man-made disaster but without major natural disasters. On the other hand, Table 1 shows that the average consumption in 1999 remained similar to the level in 1996. As will be shown below, sample households sold assets, mostly livestock, to supplement the reduced income.

In addition to the macroeconomic shock, household-level consumption was also subject to idiosyncratic shocks, thereby resulting in substantial fluctuation. Kurosaki (2006) presented a transition matrix of consumption poverty with five categories of poverty status in each year and indicated a highly frequent perturbation of the poverty status at the micro level. This variation is utilized in this section to assess the asset dynamics.

A note needs to be provided to justify the use of a dataset that is somewhat dated. The advantage of having historical semi-macro data that cover the period both before and after the micro panel survey of households is the main reason for using this micro dataset. In addition, because of the village selection strategy, the economic conditions in Village A during the panel survey appear to correspond to the semi-macro picture during the 1960s to 1970s in panel B of Figure 3, those in

Village B to the semi-macro picture during the 1980s to 1990s, and those in Village C to the semi-macro picture during the 2000s. Based on this observation, Section VI combines the microeconomic analysis in this section and the historical analysis in the previous section.

Furthermore, because of the low economic growth rates and the slow pace of social transformation in Pakistan's economy in recent decades, the basic economic behavior of households during the second half of the 1990s is of relevance to development issues in Pakistan currently. For example, the importance of livestock in the asset portfolio of households was confirmed in a recent resurvey of the study region (Kurosaki and Khan 2011). For these reasons, I regard the analysis of this panel dataset as highly relevant for the purpose of this paper.

B. Empirical Strategy

Motivated by the asset poverty trap hypothesis given by Carter and Barrett (2006), this paper follows the empirical strategy of McKay and Perge (2011). First, the shape of the asset dynamics curve is estimated, with $Y_{i,1999}$ —the asset level of household i in 1999—regressed on $Y_{i,1996}$, the corresponding value in 1996,

$$Y_{i,1999} = f(Y_{i,1996}) + u_i, \quad (1)$$

where $f(\cdot)$ is the unknown function and u_i is a zero-mean error term. To let the data determine the shape of the function, I employ a nonparametric approach to estimate the function. If the expected value of the asset in 1999 is an S-shaped function of the initial asset with three intersections with the 45-degree line, as shown in Figure 1, the long-run dynamics of assets are characterized by the middle and unstable equilibrium (the Micawber threshold) and two stable equilibria. The lower of the two stable equilibria may correspond to the poverty trap.

A parametric model is then estimated that controls for various shocks and initial conditions as the asset dynamics curve is likely to be affected by these factors. As semi-parametric analyses are computationally expensive in general and not feasible in this case due to the small sample size, I adopt a completely parametric model in which the function $f(\cdot)$ in equation (1) is proxied by a polynomial function. Thus, the following model is estimated,

$$Y_{i,1999} - Y_{i,1996} = a_1 Y_{i,1996} + a_2 Y_{i,1996}^2 + a_3 Y_{i,1996}^3 + a_4 Y_{i,1996}^4 + a_5 Y_{i,1996}^5 + X_i b_1 + D_v d_v + Z_i \gamma + u_i, \quad (2)$$

where X_i is a vector of household-level variables that might affect the asset dynamics; D_v is a vector of village dummies; Z_i is a vector of variables that characterizes shocks experienced by each household; and $a_1, a_2, a_3, a_4, a_5, b_1, d_v$, and γ are the parameters to be estimated. Note that the effect of household-level time-invariant factors on the

asset level is controlled cleanly as the first difference is employed as the dependent variable. The empirical specifications for X_i , D_v , and Z_i are discussed in the next subsection.

Using specification (2), I first examine the shape of the polynomial function—defined as the fitted values of $(1 + a_1)Y_{i,1996} + a_2Y_{i,1996}^2 + a_3Y_{i,1996}^3 + a_4Y_{i,1996}^4 + a_5Y_{i,1996}^5$ —as an asset dynamics curve conditional on X_i , D_v , and Z_i . Its shape is then compared with the unconditional counterpart estimated from equation (1). A similar parametric approach is adopted in the literature, for example, by Naschold (2005) and McKay and Perge (2011), although they use a fourth-order polynomial. If the null hypothesis of $a_2 = a_3 = a_4 = a_5 = 0$ is not rejected, the linear specification is supported.

I then examine the coefficient vectors of d_v and γ . By comparing d_v across different types of assets, one can characterize how each asset responds to village-level aggregate shocks. By comparing γ for different types of shocks and assets, it is possible to infer which asset is more responsive to a particular type of idiosyncratic shock. Although any empirical measure of household-level shocks may contain aggregate components, the inclusion of village fixed effects absorbs the effects of the aggregate components so that the coefficient γ can be interpreted as a measure of the asset response to idiosyncratic components of an observed measure of household-level shocks. Thus, equation (2) is a parameterized version of equation (1) that focuses on the asset response to shocks.²² One can refer to Mogues (2011) and Kusadokoro et al. (2012) for other empirical attempts where both equations (1) and (2) are estimated, with focus on the asset response to shocks.

With regard to the type of assets, equations for livestock and land assets are first estimated separately. An analysis of a composite asset (called the “livelihood asset” below) follows. This aggregates the vector of various types of human capital, social capital, and physical assets that contribute to the well-being of the household.

Following the empirical methodology by Adato, Carter, and May (2006), the livelihood asset is estimated in the following steps. First, for each household in each year, per capita consumption expenditure is calculated, which includes the imputed values of in-kind transactions.

Second, per capita expenditure is divided by the poverty line in each year that corresponds to the official poverty line. This measure is called the “welfare ratio” and is reported in Table 1.

Third, the welfare ratio is regressed linearly on various types of assets. The vector of assets includes village fixed effects; demographic variables (household size, female ratio, dependency ratio, female head dummy, and age of household head); the literacy rate of working-age adults; monetary assets; machinery and equipment

²² Although equation (2) allows us to examine the different responses of assets to aggregate versus idiosyncratic shocks, I cannot examine their different responses to transient versus permanent shocks due to data limitations—the two-period panel data is too short for the latter analysis.

(agricultural, nonagricultural, and consumption durables); value of owned land and livestock animals; and income sources (access to nonfarm income and remittance receipts).

The fitted value of this regression is the resulting estimate for the livelihood asset. The coefficients on assets used in the aggregation give the “marginal contribution to livelihood of the j different assets” (Adato, Carter, and May 2006, p. 233).

C. Shape of the Asset Dynamics Curves

Figure 4 shows the estimation results using the locally weighted scatter plot smoothing (LOWESS) methodology. The black curve represents the LOWESS fit, while the grey, straight line represents the 45-degree line. The shape and corresponding equilibrium values remained qualitatively the same when the fractional polynomial fit was used instead, or $f(\cdot)$ in equation (1) replaced by a polynomial function up to the fifth degree as in equation (2).

Panels A and B show that the dynamics curves for livestock and farmland have a single long-run equilibrium. As the curve intersects the 45-degree line from above, the single equilibrium is stable. The exact level of land or livestock equilibrium is close to the household average. Since the majority of the households are poor, this appears to indicate that the long-run equilibrium is associated with poverty.²³

The shape of the asset dynamics curve changes slightly when various types of assets are aggregated into a scalar of the livelihood asset following the methodology given by Adato, Carter, and May (2006).²⁴ Panel C of Figure 4 shows the results when the LOWESS method is applied to the livelihood asset. The figure depicts an S-curve with two stable equilibriums. The lower of the two corresponds to the poverty trap defined by Carter and Barrett (2006), since it is at the level around the poverty line and the other (the highest intersection) could correspond to a middle-class income level, far beyond the poverty line.

At the same time, however, observations are scattered over the fitted curve with a large variance, indicating that actual asset dynamics are subject to substantial stochastic shocks.²⁵ A large unexplained variance is evident from panels A and B as well.

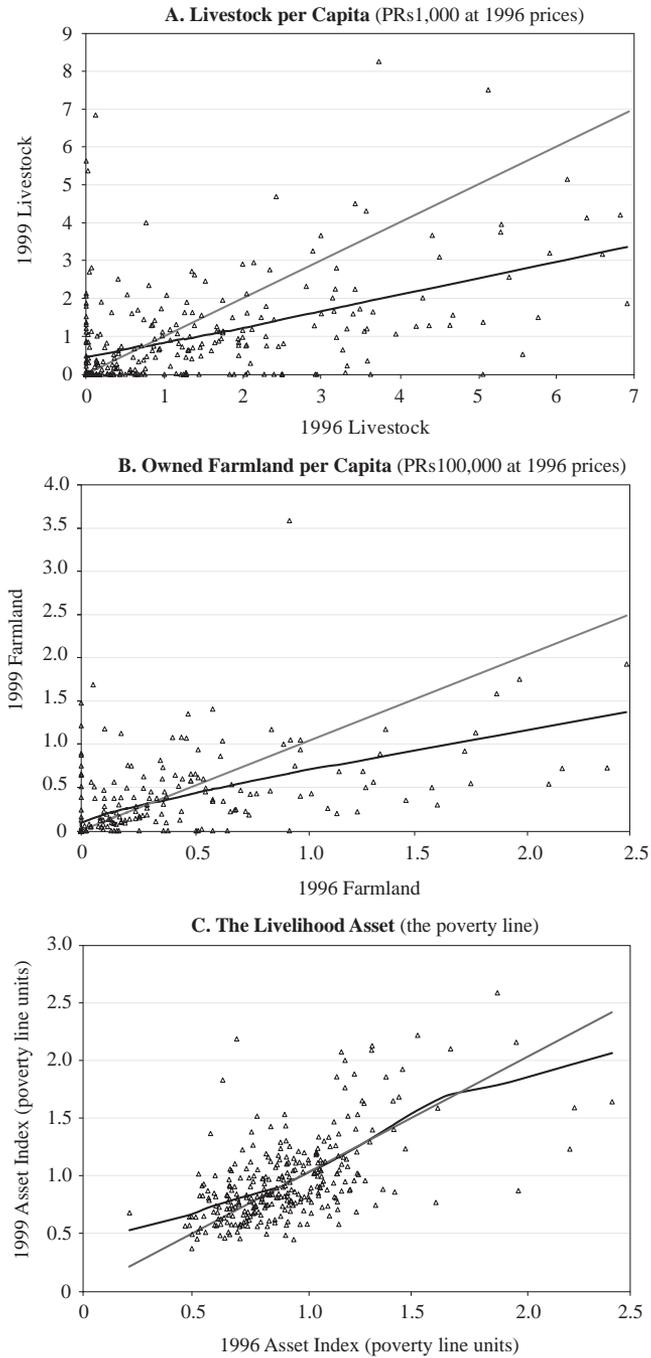
To explain some of this unexplained variance, it would be useful to control for shocks and initial conditions. For this reason, I estimate the parametric model of

²³For example, when the official poverty line was applied to the dataset, the poverty headcount ratio among the sample households stood at 67% and the poverty gap ratio at 20%.

²⁴See Appendix Table for the regression results used to construct the livelihood asset. In estimation, the larger sample including attrition or split households was used to fully utilize the cross-section information. The qualitative results remained the same when the subsample of 299 households was used.

²⁵Although not shown in the figure, the 95% confidence interval zone estimated by bootstrapped standard errors contains the 45-degree line for almost the entire distribution of the livelihood asset in 1996. Therefore, the three equilibrium points are not statistically significant. In this sense, Figure 4 confirms what is indicated in existing literature that multiple equilibriums are not found in Pakistan (Naschold 2005).

Figure 4: Nonparametrically Estimated Asset Dynamics Curves in the NWFP of Pakistan, 1996–1999



Notes: Nonparametrically estimated by LOWESS with a bandwidth of 0.8. The scatter plots on the vertical axis are raw observations without any control.
 Source: Author's computations.

equation (2). As controls for the household characteristics, X_i in equation (2), three demographic variables are included: the initial number of household members, the change in the number of household members, and the literacy rate of working-age adults in the baseline survey. These variables, together with a polynomial function of the lagged asset variables, control for households' activities and available consumption smoothing measures. Another reason for including the two variables regarding household size is that asset variables are defined such that they are affected by demographic changes by construction.

As proxy variables for household-level shocks, Z_i in equation (2), the dataset includes 14 dummy variables collected in the 1999 survey with respect to shocks that hit the household during the 3 years. From these 14 variables, I created three indicator variables that take a positive value if the household was hit by shocks that decreased its income and welfare. The three variables are shocks in farming, off-farm wage work, and others.²⁶ The definition and summary statistics of these household-level shock variables are provided in the footnotes to Table 2.

The regression results are reported in Table 2. In all three cases, the null hypothesis of linearity is rejected at the 5% level. All three coefficients on the linear lagged asset variable are between -1 and 0 , thereby suggesting local convergence evaluated at the mean.²⁷ As the null hypothesis that slopes of explanatory variables are the same across villages was not rejected except for the intercept, I report the results based on equation (2) assuming village-specific intercepts.

Based on the results in Table 2, I plot the estimated asset dynamic curves in Figure 5. The black curve represents the fitted value of $(1 + a_1)Y_{i,1996} + a_2Y_{i,1996}^2 + a_3Y_{i,1996}^3 + a_4Y_{i,1996}^4 + a_5Y_{i,1996}^5$, while the scatter plot is replaced by the observed value minus the fitted value of $X_i b_1 + D_v d_v + Z_i \gamma$. Because of the contribution of these controls, observations net of the controls are scattered over the fitted curve with a smaller variance than that depicted in Figure 4.

However, what is striking is the similarity of the asset dynamics curves. Panels A and B of Figure 5 show that the dynamics curves for livestock and farmland are associated with a single long-run equilibrium. The precise level of land or livestock equilibriums is close to the level shown in Figure 4. The shape of the asset dynamics curve for the livelihood asset appears to be an S-curve as well (panel C, Figure 5). However, the fitted curves and the 45-degree lines are very similar in the wide range of the asset level that corresponds to the welfare level that ranges between 1 to 1.75 poverty line units.

²⁶The major portion of variation in these three variables is idiosyncratic. The ANOVA decomposition suggests that the between-village components explain only 0.60% of the total variation for "Agricultural shock," 0.68% for "Off-farm work shock," and 1.05% for "Other shocks." The author's observations in the field also support this view. For example, farmers were subject to highly idiosyncratic agricultural shocks, such as plot-specific wild animal/pest attacks, farmer-specific unfavorable selling prices, etc.

²⁷The convergence test was conducted at different quartiles of the lagged asset distribution. The results were also consistent with local convergence at these evaluation points. Detailed results are available on request.

Table 2. Response of Assets to Village-level and Household-level Shocks

	Dependent Variable: Change in Assets from 1996 to 1999		
	D_livestock	D_farmland	D_livelihood asset
Initial Level of Each Asset			
Linear	-0.801*** (0.210)	-0.340*** (0.085)	-0.421** (0.186)
Squared	-0.023 (0.085)	0.300 (0.203)	0.233 (0.637)
Cubic	0.049 (0.053)	-0.155** (0.072)	1.179 (0.749)
Fourth degree	-0.007 (0.006)	0.021** (0.009)	-1.325 (1.062)
Fifth degree	0.000 (0.000)	-0.001** (0.000)	0.269 (0.803)
Demographic Controls			
Initial household size	-0.019 (0.015)	0.012 (0.008)	0.007 (0.007)
Change in household size	-0.031* (0.017)	-0.021* (0.012)	-0.023*** (0.005)
Literacy rate of working age adults	-0.329 (0.360)	0.429*** (0.131)	0.106 (0.136)
Response to a Village Level Shock (coefficient on the fixed effect)			
Village A	-0.656*** (0.137)	-0.272*** (0.088)	0.020 (0.050)
Village B	-0.699*** (0.178)	-0.109 (0.083)	-0.009 (0.054)
Village C	-0.446*** (0.164)	-0.097 (0.078)	0.100*** (0.029)
Response to a Household Level Shock			
Agricultural shock	-0.003 (0.122)	-0.021 (0.080)	-0.033 (0.032)
Off-farm work shock	-0.072 (0.233)	0.065 (0.088)	-0.055 (0.046)
Other shocks	-0.200 (0.151)	-0.138** (0.061)	-0.047 (0.040)

Continued.

Thus, Figures 4 and 5 suggest that the dynamics of household landholding and livestock are associated with a single long-run equilibrium. When human capital is added, the dynamics curve changes its shape but this is not sufficiently nonlinear to produce statistically significant multiple equilibriums. Therefore, the tentative conclusion is that the poverty trap hypothesis à la Carter and Barrett (2006) does not explain the behavior of household assets in the NWFP during the late 1990s.

D. Response of Assets to Village-level and Household-level Shocks

This subsection discusses the estimated coefficients related to the shocks presented in Table 2. First, the coefficients on village dummies, d_v in equation (2),

Table 2. *Continued.*

	Dependent Variable: Change in Assets from 1996 to 1999		
	D_livestock	D_farmland	D_livelihood asset
R-squared	0.784	0.389	0.314
F-stat for zero coefficient on nonlinear terms	7.50***	2.97**	3.73***
F-stat for homogenous village fixed effect	0.87	3.35**	1.85
F-stat for zero coefficient on household-level shocks	0.65	2.06	1.48

*** = significance at the 1% level, ** = significance at the 5% level, * = significance at the 10% level.

Notes:

1. Figures in parentheses are Huber-White robust standard errors.
2. Weighted least squares (WLS) regression with village fixed effects (no intercept) is employed, where weights are the number of household members inflated by village-specific inflation factors.
3. To make the coefficients on village fixed effects readily interpretable, the initial asset level, household size, and literacy rates are replaced by their deviations from the mean. Table 1 and Appendix Table provide summary statistics of these variables.
4. The following are the definitions and statistics of household-level shocks:
 - Agricultural shock, represented by an index of agricultural shocks experienced by the household between 1996 and 1999, with a value of +2 if the household experienced both crop failure and output prices lower than the market rate, +1 if it experienced either, 0 if it experienced neither, -1 if it experienced either a bumper crop or output prices higher than the market rate, and -2 if it experienced both. The mean is -0.074 and the standard deviation 0.721;
 - Off-farm work shock, represented by an index of shocks to off-farm work conditions of the household between 1996 and 1999, with a value of +2 if the household experienced both the loss of employment and a decrease in wage rates, +1 if it experienced either, 0 if it experienced neither, -1 if it experienced either a gain in employment or an increase in wage rates, and -2 if it experienced both. The mean is 0.036 and the standard deviation 0.532; and
 - Other shocks, represented by an index of other shocks experienced by the household between 1996 and 1999, such as unexpected deaths and funerals and discontinuation of remittances from family members living outside the village, with a value of +1 for a negative shock, 0 if there was no such shock, and -1 for a positive shock. The mean is 0.098 and the standard deviation 0.565.

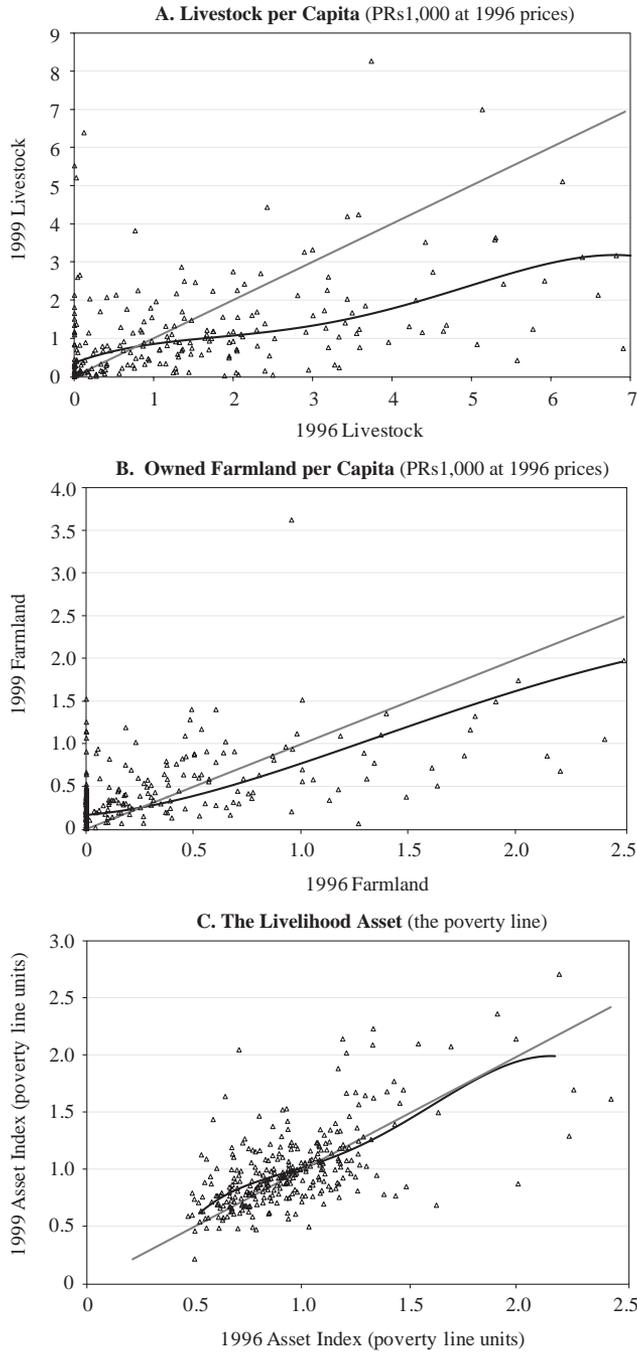
Source: Author's computations based on 1996–1999 panel data described in the text.

show an interesting contrast across the three types of assets. All three of the village fixed effects are negative and statistically significant when the dependent variable is the change in livestock assets. This indicates that sample households sold livestock to supplement the reduced income when the three villages were hit by macroeconomic stagnation.

On the other hand, there was a significant reduction in farmland in Village A only. In the farmland asset regression, the null hypothesis of homogenous village fixed effects is rejected at the 1% level. My interpretation is that this reflects the cost of inferior access to markets in Village A. Because of isolation, farm households in Village A had to sell or mortgage part of their farmland to cope with aggregate negative shocks. In contrast, farm households in Villages B and C did not need to use their land since they had access to other smoothing measures.

Another interesting intervillage difference is that the livelihood asset increased slightly in Village C, while it remained at the same level in the other two

Figure 5: **Parametrically Estimated Asset Dynamics Curves in the NWFP of Pakistan, 1996–1999**



Notes: Parametrically estimated by OLS. The scatter plots on the vertical axis are raw observations net of asset changes predicted by other controls included in Table 2.

Source: Author's computations.

villages. During the 3 years spanning the two surveys, I observed in the field that there was a rapid diversification of the economy in Village C, with growth in new activities such as the plant nursery business and commuting to the city of Peshawar. In such circumstances, the livelihood asset in this village increased because the livelihood asset is a positive function of human capital (see Appendix Table) and the human capital level increased in this village during the 3 years that the survey was conducted.²⁸ However, these are speculations without solid evidence, as village fixed effects can capture any unobservable factor.

The expectation was that the coefficients on household-level negative shocks, γ in equation (2), would be negative. Estimations revealed that eight out of nine coefficients were indeed negative (Table 2). However, only one of them (the impact of “other shocks” on the change in farmland) was statistically significant. The significant coefficient suggests that there was a depletion in farmland when the household was hit by a shock that was not related to agriculture or off-farm wage work. The overall insignificance of these idiosyncratic shocks suggests that, on average, such shocks did not directly reduce assets, and households did not need to reduce their assets after these shocks.

Thus, the estimation results reported in Table 2 regarding coefficients on shock variables are consistent with the behavior in which households use assets as a buffer. These results were robustly supported through other specifications.²⁹ For example, when the list of household initial characteristics in X_i of equation (2) was expanded, the additional variables had insignificant coefficients and other coefficients remained highly similar to those in Table 2. This is probably because the lagged asset value on the right-hand side of equation (2) already controls for most of the impact of such variables on the asset dynamics. I also attempted several alterations for the definition of household-level shocks and different weights used in regression. Regardless of the alterations, the estimation results are qualitatively the same as those reported in Table 2.

VI. Combining Microeconomic and Historical Analyses

A. Interpreting the Microeconomic Results from the Historical Perspective

The microeconomic results discussed in the previous section could be interpreted in several ways if the analysis were conducted in isolation. As historical

²⁸This interpretation is consistent with the finding by Kurosaki and Khan (2006) using the same panel dataset that education investment had high economic returns if associated with nonagricultural employment. With new opportunities for poverty reduction through human capital investment, the livelihood asset can be increased during adverse macroeconomic conditions. Households that moved out of poverty through human capital accumulation could then settle at the higher equilibrium in the S-shape curve in panel C of Figure 4.

²⁹The estimation results under alternative specifications are available on request from the author.

semi-macro data are available encompassing the period both before and after the panel data collected, the information derived from these data can be utilized to narrow down the interpretation.

First, with regard to the shape of the asset dynamics curve, the microeconomic results for land and livestock suggest an absence of multiple equilibriums. This is further supported by the historical finding of an absence of persistent declines in livestock population after independence. When human capital was included, the results were ambiguous due to statistical insignificance of multiple equilibriums. Therefore, without other indirect evidence, this paper concludes that no evidence is found for multiple equilibriums. If historical data were available on the average level and distribution of education at the district level, it would be possible to provide further support or refutation to this tentative conclusion. As speculated in the previous subsection, my field impression is that it is possible that multiple equilibriums existed in recent years when human capital became the key component of the livelihood asset. This possibility could be investigated in further research with other datasets.

Second, regarding the response of household assets to shocks, the results of the microeconomic analysis reveal how livestock declined rapidly in all villages when these villages were hit by macroeconomic shocks. Since there was no natural disaster that caused the death of livestock during 1996–1999, the negative coefficients cannot be interpreted in the same way as for 1920/1921 when livestock animals died due to droughts. Therefore, this is evidence that livestock had been used as a buffer against negative aggregate shocks during the 1990s.

The change in the livestock portfolio over the century (Figures 2 and 3) is worth attention in this regard. Since draft animals were an indispensable part of crop production in the old days, it was difficult for farmers to reduce the stock even in difficult years. In contrast, the number of milk animals can be reduced more easily and the increasing share of such animals in the livestock portfolio of households has facilitated the effectiveness of livestock as a buffer. Thus, the microeconomic results in Table 2 can be better understood with the help of long-term historical evidence.

Furthermore, the microeconomic results regarding household idiosyncratic shocks showed that assets declined on average, but the decline was not statistically significant. Among the shocks, the adverse impact of “other shocks” such as unexpected deaths and funerals and discontinuation of remittances from family members living outside the village was statistically significant in the land regression.

The results could be interpreted as showing heterogeneity among villagers and among the type of shocks in terms of the extent of insurance against idiosyncratic shocks. This interpretation is indirectly supported by the historical analysis if the cross-sectional difference is compared with changes over time. The historical analysis showed that the livestock population at the district level became less responsive to crop shocks in more recent years with the development of infrastructure, agricultural technology, and intertemporal resource allocation opportunities.

B. Reinterpreting the Historical Patterns

It was speculated in Section IV that: (i) pre-independence livestock dynamics were consistent with both the asset poverty trap hypothesis and the buffer stock hypothesis, while the post-independence livestock dynamics were more consistent with the buffer stock hypothesis; and (ii) the contrast could be attributable to different levels of infrastructure, formal credit facilities, and agricultural technology.

The microeconomic findings in Section V are broadly supportive of these conjectures. They reveal that during the late 1990s assets were indeed used as a buffer. The between-village contrast also supports the contention that as an economy develops, the function of assets in smoothing consumption against shocks strengthens. As the buffer stock hypothesis was supported even for the least developed village in the microeconomic analysis, it appears more likely that asset dynamics during the pre-independence period was also more consistent with the buffer stock hypothesis than with the poverty trap hypothesis.

As a final remark on combining the two types of analysis, let us consider a prediction regarding the district livestock population, which is theoretically derived from the conclusion that the asset dynamics of livestock follow the buffer stock hypothesis. As discussed in Section II, the theoretical prediction is that the decline in the livestock population witnessed at the micro level during the 1996–1999 period should be temporary. Panel B of Figure 3 indeed supports this—the change in the livestock population from 1996 to 2006 is connected with the change from 1986 to 1996 without a significant discontinuity in the growth rates.³⁰

However, it must be noted that to infer district-level dynamics from micro-level analysis, one needs to specify how initial assets are distributed across households and villages over the entire district and how livestock markets behave in response to district-level changes. The previous prediction is based on a simple assumption that the initial livestock distribution is the multiple of the three villages analyzed and that there is no market equilibrium effect in the livestock markets. Further research is necessary to replace this assumption by a numerical model based on hard data and an appropriate microeconomic model.

VII. Conclusion

This paper analyzed asset dynamics held by low-income households in the NWFP area in Pakistan over a period from 1902 to 2011. I first investigated the long-run data at the district and province levels. The results showed how the population of

³⁰The following are the annual growth rates of the livestock population in Panel B of Figure 3 (the first number shows the growth from 1986 to 1996 and the second from 1996 to 2006): bullocks as draft animals (–6.4% and –2.0%), adult cows in milk (+1.2% and +2.7%); and adult she-buffaloes in milk (+7.5% and +4.3%).

livestock—the major asset of rural households—declined with crop shocks due to droughts, but did not respond much to the Great Depression. The decline in livestock due to droughts was persistent. In the post-independence period, crop agriculture continued to be vulnerable to natural disasters, although less substantially so, while the response of livestock to such shocks was indiscernible in district-level data.

I then analyzed a panel dataset collected from approximately 300 households in three villages in the NWFP during the late 1990s. Results showed that the dynamics of household landholding and livestock were associated with a single equilibrium. When human capital was included, however, the dynamics curve changed its shape, though this was not sufficiently nonlinear to produce statistically significant multiple equilibriums. On the other hand, the response of household assets to village-level and household-level shocks showed several interesting patterns—livestock assets were depleted widely when the village economy was affected by macroeconomic stagnation, land assets were depleted only in a village with inferior access to markets, and idiosyncratic agricultural and off-farm work shocks did not substantially affect household-level asset dynamics.

To understand these patterns revealed from historical and contemporary analyses, the paper suggested the possibility that the contrast could be attributable to the different levels of infrastructure, formal credit facilities, and agricultural technology. Considering the long-run historical data, the household panel data during the 1990s appear to show that there had been an improvement in access to consumption smoothing measures such as asset sale markets, credit institutions, and reciprocity-based transfers. However, the improvement was not homogenous, leaving pockets of villages and households with inferior access. In this regard, the role of livestock as liquid assets was found to be important in smoothing consumption while the role of less liquid assets, particularly land, was more limited. The reduction in the number of draft animals in the livestock portfolio in the long-term, and their replacement by milk animals, facilitated the effectiveness of livestock as a buffer against negative shocks.

On the other hand, throughout the period since the early 20th century, financial markets existed in cities in the NWFP, and villagers had a network of credit transactions. However, the actual use of modern financial markets and formal credit institutions did not prevail widely in the early stage of development. The highly unequal distribution of land in Pakistan could have accentuated the disparity, as land is often used as collateral in formal credit transactions.

These interpretations imply that improving the intertemporal smoothing ability of households through the development of assets and credit markets is key to mitigating the adverse effects of natural disasters. It is also expected that investment in infrastructure such as for transport and communication could contribute to higher resilience against natural disasters as it would facilitate the movement of labor and improve the level of efficiency of risk sharing and credit transactions.

It must be noted that these interpretations and policy implications are merely speculations. A limitation of this paper is that the attempt to demonstrate the complementarity of combining historical and contemporary analyses is incomplete. Because of data limitations, the paper was unable to investigate the asset dynamics during the pre-independence period in a microeconomic way. This is left for further research. Nevertheless, as a policy-oriented research, this paper shows the potential benefit of empirical analyses that combine both contemporary and historical information. Economic development is, by definition, a long-term process. A microeconomic test of a particular structure of incomplete markets needs to be aligned with the historical context.

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Appendix Table: **Estimation of the Livelihood Asset through Regression Analysis**

	Dependent Variable: Welfare Ratio			
	1996		1999	
	Summary Statistics	Regression Results	Summary Statistics	Regression Results
Village-specific Intercept				
Village A	0.201 (0.402)	1.003*** (0.115)	0.206 (0.405)	0.937*** (0.131)
Village B	0.270 (0.444)	1.104*** (0.117)	0.251 (0.434)	0.948*** (0.120)
Village C	0.529 (0.500)	1.197*** (0.123)	0.544 (0.499)	1.123*** (0.121)

Continued.

Appendix Table: *Continued.*

	Dependent Variable: Welfare Ratio			
	1996		1999	
	Summary Statistics	Regression Results	Summary Statistics	Regression Results
Household Wealth Characteristics				
Number of household members	11.843 (6.854)	-0.012** (0.006)	12.222 (7.606)	-0.006 (0.005)
Ratio of females in the household	0.484 (0.129)	-0.017 (0.143)	0.483 (0.126)	0.070 (0.182)
Ratio of dependent members in the household	0.488 (0.184)	-0.481*** (0.136)	0.492 (0.189)	-0.644*** (0.133)
Dummy for a female-headed household	0.005 (0.072)	-0.261** (0.121)	0.014 (0.118)	0.007 (0.128)
Age of the household head	52.259 (16.411)	-0.001 (0.001)	54.735 (15.809)	0.001 (0.001)
Literacy rate of working-age adults	0.278 (0.257)	0.349*** (0.101)	0.323 (0.258)	0.176* (0.092)
Per capita value of household assets such as agricultural machinery, transport equipment, durable goods, etc. (PRs1,000 in 1996 prices)	2.494 (6.259)	0.015** (0.007)	0.597 (0.963)	0.219*** (0.043)
Per capita outstanding credit including informal lending to others (PRs1,000 in 1996 prices)	0.967 (5.778)	0.017*** (0.003)	0.719 (3.605)	0.013 (0.013)
Per capita value of farmland owned by the household (PRs100,000 in 1996 prices)	0.488 (1.500)	0.081*** (0.020)	0.366 (0.919)	0.120*** (0.024)
Per capita value of livestock owned by the household (PRs1,000 in 1996 prices)	1.531 (2.656)	0.039*** (0.011)	0.934 (1.297)	0.060* (0.034)
Dummy for households with workers employed in nonagricultural employment on a permanent basis	0.551 (0.498)	-0.013 (0.047)	0.583 (0.494)	-0.089** (0.043)
Dummy for households that regularly receive remittances from family members living separately	0.086 (0.281)	0.164* (0.097)	0.184 (0.388)	0.127* (0.075)
Mean of the dependent variable/R-squared	0.957	0.893	0.994	0.902
Standard deviation of the dependent variable/ F-stat for zero slopes	(0.473)	14.28***	(0.512)	15.71***
Number of observations	354	354	351	351

*** = significance at the 1% level, ** = significance at the 5% level, * = significance at the 10% level, PRs = Pakistan rupees.

Notes:

1. In the summary statistics column, weighted means are reported with standard deviations given in parentheses.
2. In the regression results column, figures in parentheses are Huber-White robust standard errors.
3. WLS regression with village fixed effects (no intercept) is employed.
4. Weights are the same as those described in Table 2.
5. In the 1996 regression, the number of observations was 354 as one observation had been excluded due to nonavailability of consumption data. In the 1999 regression, the number of observations was 351 as split and replacement households had been included.

Source: Author's computations based on 1996–1999 panel data described in the text.