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FOOD AVAILABILITY, ENTITLEMENTS AND THE CHINESE FAMINE OF 1959–61*

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Food availability decline and Sen's entitlement are two leading approaches in understanding causes of famine. Previous research based on case studies has given independent support to each approach. This paper analyses the Chinese famine of 1959–61 by considering jointly the urban bias and the decline in food availability as causes. We find that both factors contributed significantly to the increase in death rates during this famine. To our knowledge, this paper is the first econometric study to assess the importance of famine causes using the entitlement approach.

The problem of famines and food shortages has received much attention from economists because such crises continue to occur despite persistent progress in agricultural production technology. The traditional approach to famine analysis, which dates back to the writings of Adam Smith and Malthus, proposes that famines are primarily caused by a sudden decline in food availability (FAD). For example, a war or a natural calamity may decimate agricultural production in a particular geographic region and result in widespread food shortages that lead to famine. This supply-based FAD account was an accepted explanation for famines before the influential work of Sen (1977, 1981*a*,*b*), who proposed a more general entitlement approach. Sen emphasised that famine was a situation in which a significant number of people in a region failed to acquire enough food to eat. While a shortage in *per capita* food output may cause famine, it is only one of many possible causes. In his studies of several well known historical famines, Sen found that famines occurred even when *per capita* food output was maintained. Famines resulted either from sudden collapses in the endowments of population subgroups or from dramatic changes in relative prices, which caused some of the population to fail to acquire enough food.

While the entitlement approach has been accepted by many famine analysts, proponents of the FAD approach have offered criticism.[1] Instead of examining food availability at aggregate levels as Sen did, opponents emphasise local supply conditions. They argue that crop failures due to natural calamities often result in high food prices because of supply shortages, speculative behaviour, increased demand to deal with uncertainty, and sales of possessions to obtain food. Ultimately, the poor and those who are negatively affected by bad weather become famine victims because of reduced purchasing power. Since

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[1] See, for example, Seaman and Holt (1980), Cutler (1984) and Bowbrick (1986). Ravallion (1997) provides a comprehensive description of the entitlements approach and its critics.

crop failures initiate the chain of effects, the proponents of this approach argue that the best way to understand famines is to look at what happened to food availability.[2]

Despite the clarity of views at the theoretical level, the usefulness of the two approaches has not yet been rigorously examined in empirical analysis. Although Sen has amply demonstrated that famine could occur without a reduction in *per capita* food supply, his measures of availability are defined at either national or highly aggregated regional levels, which may not directly refute the propositions of FAD proponents who emphasise local conditions.[3] A formal assessment of the entitlement approach is further obstructed by other data limitations, such as the lack of records on personal property and detailed market commodity prices. More importantly, previous research has not measured separately the contributions of food supplies and other entitlement arrangements to a famine. As a result, we still do not know the relative importance of the famine causes.

In this paper, we analyse the Chinese famine of 1959–61, where the drop in food availability and different arrangements of rights to food were both important factors. Under the centrally planned regime, China had an effective, urban-biased ration system in which city residents were given legally protected rights to acquire a certain amount of food. In contrast, compulsory grain procurement quotas were imposed on the farmers. As a result, farmers were entitled only to the residual grain. In years of poor harvest, there was barely enough grain left in the village for the farmers after they fulfilled the quotas. During the Great Leap Forward in 1959–61, Chinese agricultural production collapsed because of a sudden institutional change, natural calamities and a series of policy mistakes. The grain output dropped by 15% in 1959 and reached only about 70% of the 1958 level in 1960 and 1961. Careful studies of the newly released data reveal that this crisis resulted in widespread famines and caused about 23–30 million excess deaths (Peng, 1987 and Ashton *et al.* 1984). To analyse this catastrophe, we apply Sen's entitlement approach to the centrally planned system. We formulate a framework that is amenable to empirical testing and that simultaneously considers *per capita* food supply and the right to food as determinants of famine.[4]

A panel data set for 28 Chinese provinces for the period 1954–66 is used for the empirical analysis. We use the percentage of rural population and *per capita* grain output in a province as proxies for the degree of urban bias and

[2] Sen's entitlement approach does not oppose food availability decline as a cause (hypothesis) for famine. What the entitlement approach opposes is to take food availability as the only cause for famine. See Osmani (1995) for further discussions on the differences between the FAD approach and the entitlement approach. We owe this clarification to an anonymous referee.

[3] Due to data limitations, Sen (1981*a*) used national *per capita* grain output as the indicator for food availability in the study of Ethiopian and Bangladeshi famines. Presumably, *per capita* food supply in a famine region is a more relevant indicator. For the great Bengali famine, Sen used food availability figures for the district, a more local indicator, as *per capita* availability measures. However, Bowbrick (1986) questioned the reliability of the production figures.

[4] Our focus is on the causation of famine. See Coate and Ravallion (1993) for discussions on insurance arrangements and Dreze and Sen (1989, 1990) for the role of government in famine prevention and relief.

the extent of food availability, respectively, in that province and assess their contributions to the observed cross-province differences in death rates. We find that, in normal years, the cross-province differences in the variables did not result in cross-province differences in death rates. However, in the famine period of 1959–61, both variables contributed significantly to the observed inter-provincial differences in mortality rates. To our knowledge, this paper is the first serious econometric study to assess the relative importance of famine causes using the entitlement approach.

1. China's Food Procurement and Entitlement

In the entitlement approach, Sen (1981*a*,*b*) proposes that the acquisition problem is central to questions of hunger and starvation in the modern world. Consider a person's endowment vector **x**, which may include the possession of land, labour services, health conditions, and the ownership of other properties. The person may produce his own food based on initial endowment, or he may exchange possessions in the market for a consumption bundle that includes food. This person starves if he fails to obtain enough food. This may occur either through a fall in the endowment vector **x** (direct entitlement failure), or through an unfavourable shift in the terms of exchanging properties for food (trade entitlement failure). Consequently FAD is not a necessary condition for famine.[5] Towards testing his propositions, Sen recognised that there could be ambiguities in the specification of entitlement, and this problem could be compounded by data limitations.[6] Instead of conducting statistical analysis, Sen relied heavily on the indices of rice-exchange rates and the price ratios of other products or services to rice as major indicators of changing entitlement relations. He found that sharp declines in the food-exchange rates for people in selected occupations explained many of the famines.[7]

In contrast to the market environment where Sen laid out his entitlement theory and applications, China had a planned economic structure where the acquisition and distribution of food were directly controlled by the central government. Rural people had to deliver quotas to procurement agencies at prices set by the government. A food rationing system existed in cities where urban residents had protected legal rights for certain amount of grain consumption. In this planned setting, Sen's entitlement approach is still appropriate for understanding the causes of famine.

In the wake of the founding of the People's Republic in 1949, an in-kind agricultural tax was the main vehicle by which the state acquired grain from

[5] For an assessment of the entitlement approach that describes its conceptual apparatus, the evolution of Sen's analysis, and the contrast with FAD approaches, see Osmani (1995).

[6] In the absence of a market-clearing equilibrium, for instance, entitlement may not be well defined. There is also a great deal of ambiguity in characterisations of a person's possessions. See Sen (1981b) for additional explanations.

[7] In addition to Sen, Ravallion (1987) and Dyson (1991) analysed higher food prices as a proximate cause of food entitlement collapse.

rural areas.[8] Grain markets existed alongside the state grain distribution system. In 1953, the central government introduced a system of Unified Procurement and Unified Sale for grain and oil-bearing crops, which brought all grain procurement and distribution under its direct control, as a way to suppress food prices. Interprovincial grain trade by private traders was virtually eliminated. Accompanying the Unified Procurement and Unified Sale was a rigid household registration system, which deprived the rural population of the right to move to urban areas and thereby put the country-to-city migration under the government's tight control. The aim of these schemes was to extract as much agricultural surplus as possible to facilitate the heavy-industry-oriented development strategy that had resulted in an increased demand for grain and other agricultural products for urban food consumption and exports.[9] Under Unified Procurement and Unified Sale, the central government set the target for purchase of grain nationwide before a production season began. The target depended on the planned urban consumption needs, urban reserves, industrial materials and international trade. The target filtered down through provinces and lower levels of government until it reached the basic production units and became mandatory quotas. The quotas specified the quantity of compulsory deliveries as well as their prices set by the state. When quotas were fulfilled, peasants were free to sell the remaining surplus to the state procurement departments or at state-regulated grain markets. In practice, however, because the state often procured to the maximum possible extent, farmers were left with little surplus (Walker, 1984).

After harvests, grain procurement agencies in each locality collected the quotas and delivered the grain to the state. The central government then distributed the grain to the urban population in each province at subsidised prices. To control urban food demand and to facilitate the distribution of food to targeted groups, food ration coupons were introduced in 1954 (Walker, 1984). In August 1955 the government established a more formal system and set up ration standards according to age, employment and other demographic characteristics.[10] In subsequent years, the ration norms were adjusted, and the scope of rationing was extended to other agricultural products, including soy beans, coarse grains, cotton cloth, edible oil, and pork.

[8] Agricultural taxes were used by the government as early as 1938 in the Shansi-Gansu-Ningxia liberated regions (Perkins, 1966). The rate was set at 12% of the 'normal' yield in the early 1950s. The rate fell to 6% in 1970 and then to 5% in 1978 (Perkins and Yusuf, 1984). The share of grain acquired through taxes declined over time in total grain procurement.

[9] The demand came from several sources. First, the urban population increased dramatically from 57.65 million in 1949, to 71.63 million in 1952, and to 99.49 million in 1957. Second, since over 70% of China's exports had been agricultural and processed agricultural products before the mid-1970s, the country's capacity to import capital goods for industrialisation depended on the growth of agriculture. Third, agriculture was the main source of raw materials for many industries, such as textiles and food processing.

[10] For example, in 1956 the monthly ration of grain for unusually hard labourers ranged between 22.5 and 27.5 kilograms (kg) with a national average of 25 kg; for hard labourers, it ranged between 17.5 and 22 kg with a national average of 20; for light labourers, it ranged between 13 kg and 17 kg with a national average of 16 kg; for white collar employees, it ranged between 12 kg and 14.5 kg with a national average of 14 kg; and for college and high school students, it ranged between 13 kg and 16.5 kg with a national average of 16 kg (Chen, 1982, p. 206).

The urban consumption rations were matched closely with the rural compulsory quotas. The former represented protected legal rights for city residents and the latter represented coercive burdens on the rural people. Under the procurement and ration system, there were serious conflicts between the government and the peasantry. Since the government gave priority to industrial development, it pursued a heavy procurement policy to feed the expanding city population, to provide raw materials, to accumulate city grain stocks and to export grain for foreign exchange. However, more grain acquisition implied a greater extraction from agriculture, which unavoidably created strong opposition.[11] Despite conflicts, the government was always successful in acquiring grain for cities, relying on effective administrative and political methods.[12]

A production unit's mandatory quota, specified prior to an agricultural season, generally depended on the production unit's normal outputs in previous years and its current consumption needs. In normal years, farm households would be left with enough food to meet subsistence needs. If the decline in grain output was a local phenomenon, the national or provincial government might reduce quota obligations or even deliver grain relief to the farm households in the areas with bad harvests. However, if there was a severe reduction in food supply nationwide, rural people would endure most of the consequences, and a famine was likely to occur in rural areas because the government's predominant concern was urban food supply.[13] Given the above institutional arrangements in China, local food output declines and the urban-biased grain distribution system could be the fundamental causes of the Chinese famine.[14]

The above discussions give useful hints for identifying proxies and units of observations for analysing the relative importance of famine causes in the Chinese context. First, the entitlement was related to a household's legal status as urban or rural. The urban households were entitled to grain rations guaranteed by the state, whereas the rural households had the right only to the residual grain supply after fulfilling quota obligations. Second, the relative

[11] Walker (1984) provided various accounts of rural opposition to the Unified Purchase and Unified Sale schedule. Crimes were committed against the coercive acquisition and people who were responsible for the crimes were sentenced, with penalties including imprisonment and even death. The instability caused by grain procurement caught the attention of Mao Tse-tung who expressed concerns in his writings. Mao (1967) recorded: 'Old women blocked the road and would not allow the grain to be taken away . . .' and ' . . . At the time you (Minister of Agriculture) said there was no grain problem but I said there was.'

[12] For instance, the formation of large-scale agricultural organisations enhanced the control of rural cadres over large quantities of grain. To achieve promotions, the cadres had incentives to enforce procurement policies. As noted by Perkins and Yusuf (1984, p. 4), the foremost feature of China's rural development has been the government's capacity to implement village-level programmes on a nationwide basis through bureaucratic and party channels.

[13] Similar urban-biased food distribution arrangements were also observed in former socialist countries in Eastern Europe and former Soviet Union. 'In years of poor harvest even seeds for the next year and foodstuff for the farmers' own consumption were barely left in the village.' (Kornai, 1986, pp. 1071–2).

[14] Sen (1983) made an interesting contrast between India and China. He observed that China was more successful in eliminating malnutrition for the population while India had a better record in avoiding major famines. Sen attributed these observations to differences in political institutions.

price of grain to other commodities had limited power in explaining starvation in China because grain was rationed in urban areas and the grain market in rural areas during a famine was too thin to be meaningful. Third, because interprovincial grain trade by private traders was prohibited and the central government did not have the capacity to deliver relief to rural areas during the period of a sharp decline in grain output nationwide, the subsistence of farmers in a province during that period depended on the food production in that province.

These specific institutional arrangements provide a convenient way to test the validity of FAD or entitlement as an appropriate approach for understanding famines. The per capita grain output in a province can be used as the proxy for food availability in that province. If FAD is the appropriate approach, food availability would be the only variable responsible for the famine deaths. In the Chinese setting, a person's entitlement to food was legally determined by his/her residence status.[15] The proportion of rural population in a province represented the proportion of population in that province who did not have legally protected rights to food. It is a proxy for the degree of urban bias in that province. If Sen's entitlement approach is the right framework to understand the causes of a famine, the urban bias might also be a significant variable in determining famine deaths in addition to food availability.

To be specific, the hypothesis we seek to test in the regression analysis can be summarised as follows:

> In a famine in China, the death rate in a province is positively related to the proportion of rural population in that province (urban bias hypothesis) and negatively related to *per capita* grain output in that province (food availability hypothesis).

We will use the serious famine that occurred in 1959–61 in China as our case study. In the next section, we document grain production declines, issues of procurement, and the resulting famine. In Section 3, we conduct a statistical assessment of the relative effects of food availability and urban bias on the observed deaths from this human disaster.

2. Collectivisation and Demographic Crisis: 1959–61

China's agricultural collectivisation started in 1952. The farming institution was changed from household farms to mutual aid teams, to elementary cooperatives and then to advanced cooperatives that consisted of about 150 households. The advanced cooperative was the major farming institution by 1957. Agricultural output increased continuously in the period 1952–7 with an average annual growth rate of 4.6%. Encouraged by this success, the Communist party decided to adopt a bolder approach to mobilise surplus labour to

[15] We do not need to worry about how to measure a household's property and exchange entitlements as these two variables were not important determinants of the rights to food in the specific socialist setting in China.

increase capital formation.[16] In 1958, large-scale communes were formed as part of a nationwide Great Leap Forward movement.[17] Contrary to expectations, however, agricultural production plunged dramatically for three successive years and widespread famine ensued. During 1959–61, the death rate per thousand people increased dramatically while the crude birth rate per thousand people declined equally precipitously (see Fig. 1).[18]

Economists have attempted to explain the causes of the sudden reduction in agricultural output. Conventional hypotheses include three successive years of bad weather, bad policies and bad management in the communes, and incentive problems due to the unwieldy, large size of the communes (Eckstein, 1966; Chinn, 1980; Ashton *et al.*, 1984 and Perkins and Yusuf, 1984). Lin

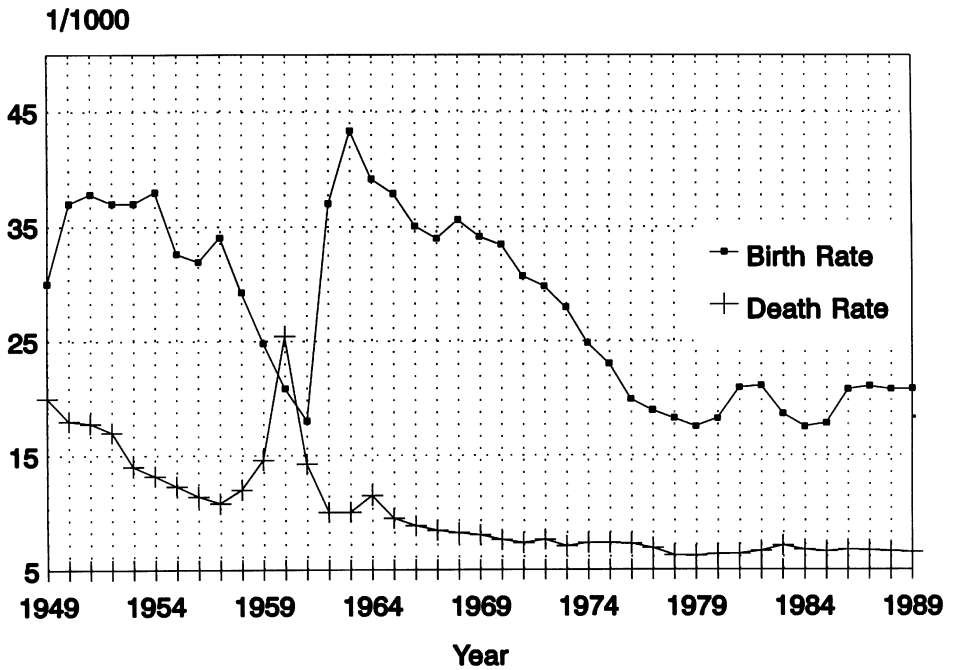

Fig. 1. *Birth Rate and Death Rate in China, 1949–1989.*
Source: State Statistical Bureau (1990, p. 2).

[16] Projects of capital formation include constructing irrigation systems, such as dams and reservoirs, building infrastructure, or the like. Mechanisation was also used as a rationale for increasing the size of a collective.

[17] The principal characteristics of the Great Leap Forward may be summarised by policies related to technology, management and planning, and industries and ideology. See Riskin (1987) for additional descriptions.

[18] As shown in Fig. 1, the changes in population trends started in 1958. However, the increase in the death rate and the decline in the birth rate were likely to have been the result of massive mobilisation for producing steel by means of the traditional iron-casting furnaces, which were set up in backyards all over China in 1958 as one of the most important components of the Great Leap Forward movement. Since the technique was extremely labour-intensive, people did not have time or did not give enough attention to health care and reproduction.

(1990) proposed a game theory explanation that the main cause of the agricultural collapse was the deprivation of the peasants' right to withdraw from the collectives. This switch in the form of organisation changed the incentive structure for the peasants and consequently undermined agricultural productivity. In this paper, we do not investigate the determinants of the sudden drop in output; instead, we focus on the consequences of the supply shock. More specifically, we analyse the relative importance of food availability and legal entitlement to food in causing the subsequent famine.

Statistical figures in Table 1 reveal that there were sharp reductions in grain availability for the period 1959–61.[19] Prior to the collapse, the total grain output continued to increase, reaching a record high in 1958 with 200 million tons. In 1959, total supply suddenly dropped by 15% and, in the following two years (1960 and 1961), it was even worse, reaching only about 70% of the 1958 level. There was slow recovery from the slump in the subsequent years. The 1958 grain production level was not regained until 1966.

During the food crisis, grain availability per person declined even more severely because, in the first two years, grain exports reached historical heights. As shown in Table 1, net grain export increased from 2.7 million tons in 1958 to 4.2 million tons in 1959. When combined with the decline in output, this resulted in a 17% and a further 13% reduction in per capita food supply in two consecutive years. Pressured by the food emergencies, China imported 4.5

Table 1.
Grain Output, Procurement and International Trade

Year	Output (million tons)	Quota (million tons)	Quota/Output (%)	Net export (million tons)	Per capita grain (kg/year)
1954	169.52	50.89	30.02	1.7	278.5
1955	183.74	47.54	25.87	2.1	295.5
1956	192.75	40.22	20.87	2.5	302.8
1957	195.05	45.97	23.57	1.9	298.7
1958	200.00	51.83	25.92	2.7	299.0
1959	170.00	64.12	37.71	4.2	246.7
1960	143.50	46.54	32.43	2.7	212.7
1961	147.50	36.55	24.78	−4.5	230.8
1962	160.00	32.42	20.26	−3.9	243.6
1963	170.00	36.99	21.76	−4.5	252.3
1964	187.50	40.14	21.41	−4.7	272.6
1965	194.53	39.22	20.16	−4.0	273.7
1966	214.00	41.42	19.35	−3.6	291.9

Source: State Statistical Bureau, (1990, p. 12, p. 26). Ministry of Agriculture, Planing Bureau (1984, p. 434).

[19] Here and in the subsequent analysis, we use data between 1954 and 1966. This specific period is taken for consideration because important demographic statistics, such as death rate, are missing for some provinces prior to 1954. The period ends in 1966, the beginning of the Cultural Revolution, when the nation entered a distinctly different historical era.

million tons of grain in 1961 which helped to reduce the food deficiency. Since that year, China has become a grain importer.

While the massive food shortage was a plausible cause of the famine, another important factor was the food entitlement to the farm population. Table 1 shows, despite the sharp decline in grain supply, the total procurement reached a peak of 64.12 million tons, which drastically raised the quota-output ratio from 25.9% in 1958 to 37.7% in 1959. The quota-output ratio remained at 32.4% in 1960 despite further reduction in grain output. As a result, the excessive procurement severely reduced the food supply to which rural people were entitled.[20]

The large quantities of grain acquisition in 1959–60 were due to several plausible reasons. First, the newly launched industrial Great Leap Forward increased the demand for grain not only for use as raw materials and sources of export but also for consumption in cities. Riskin (1987) documented that the employment in state industries tripled from 7.8 million in 1957 to 23.16 million in 1958, with a net inflow of 15.68 million agricultural labourers.[21] Consequently, with larger population in the cities, the state had to raise its compulsory quota. In the winter of 1958–9, however, urban grain supplies began to fall short of the planned allocations. To guarantee the success of the Great Leap Forward, Chairman Mao made an important speech in the spring of 1959 and described the nation as 'one chessboard', a policy that reaffirmed the central planning of grain and gave a high priority to city grain supplies over rural localities. This policy was rigorously implemented in 1959 (Walker, 1984). A second possible reason for heavy procurement was the bumper harvest of 1958, which made the central government believe that China had solved its 'grain problem'. The government simply increased procurement to claim its own share of the harvest.

Nevertheless, a careful examination of evidence favours the first explanation, i.e., that the central government harshly squeezed the peasantry on behalf of urban residents. The evidence simply does not support the explanation that the excessive deprivation of grain resulted from misjudgments of supplies. Fierce procurement campaigns were conducted by the government in 1959, and at the same time the government realised that peasants were using all means available to prevent the state from taking their grain.[22] The strong local resistance would have quickly corrected any illusion of a production miracle, but the state continued to take coercive actions. The state utilised effective political strategies to induce rural cadres to hand over grain and

[20] See Peng (1987) for additional information on inter-provincial differences in *per capita* grain output, government procurement, and grain availability.

[21] Other studies indicate similar magnitudes of urban immigration. Ashton *et al.* (1984) reported that the net inflow of urban population was about 31 million between 1958 and 1960. Walker (1984) described that, between the end of 1957 and the end of 1958, urban population increased by at least 13 million, or approximately 13%. Bernstein (1984) provided similar migration numbers as Ashton *et al.* and pointed out that most of the inflow took place in the second half of 1958.

[22] Actions taken by the peasantry were found in Mao's writings (1967). They hid things in 'secret cellars, ... posted sentries. ... ate turnips during the day and concealed rice at night.' See Walker (1984) and Bernstein (1984) for additional descriptions.

punished those who resisted orders. The formation of large-scale people's communes provided opportunities to the cadres to mobilise large amounts of grain (Bernstein, 1984). The result of the procurement campaign in 1959 was astonishing. The state managed to increase grain collection by about 24% even though actual grain output plunged by 15%.

Accompanying the sharp reduction in food supply and excessive procurement was massive famine in China for three consecutive years between 1959 and 1961. However, this famine went unnoticed outside of China until the release of important demographic data by the Chinese government in the early 1980s.[23] In a careful study of the population statistics by interpolating between pre- and post famine mortality levels, Ashton *et al.* (1984) concluded that 'the number of excess deaths during the crisis amounts to about 17.3 million deaths over the age of 10 and 12.2 million deaths under age 10, giving a total of almost 30 million excess deaths.' Measured by number of deaths, this disaster is, undoubtedly, the worst famine in the history of the world.

Table 2 presents summary statistics for the period 1954–66 on the Chinese population, its death rate, and birth rate, including separate accounts for rural and urban areas. Largely an agrarian economy, the share of rural population was above 80% in the entire period. The death and birth figures clearly demonstrate a major demographic catastrophe between 1959 and 1961. The national death rate increased from 11.98 per thousand in 1958 to 14.59 per

Table 2.
Summary Statistics of Population, Death Rate and Birth Rate

	Population			Death Rate			Birth Rate		
Year	Nation (millions)	City (%)	Country (%)	Nation (0.1%)	City (0.1%)	Country (0.1%)	Nation (0.1%)	City (0.1%)	Country (0.1%)
1954	602.66	13.7	86.3	13.18	8.07	13.71	37.97	42.45	37.51
1955	614.65	13.5	86.5	12.28	9.30	12.60	32.60	40.67	31.74
1956	628.28	14.6	85.4	11.40	7.43	11.84	31.90	37.87	31.24
1957	646.53	15.4	84.6	10.80	8.47	11.07	34.03	44.48	32.81
1958	659.94	16.2	83.8	11.98	9.22	12.50	29.22	33.55	28.41
1959	672.07	18.4	81.6	14.59	10.92	14.61	24.78	29.43	23.78
1960	662.07	19.7	80.3	25.43	13.77	28.58	20.86	28.03	19.35
1961	658.59	19.3	80.7	14.24	11.39	14.58	18.02	21.63	16.99
1962	672.95	17.3	82.7	10.02	8.28	10.32	37.07	35.46	37.27
1963	691.72	16.8	83.2	10.04	7.13	10.49	43.37	44.50	43.19
1964	704.99	18.4	81.6	11.50	7.27	12.17	39.14	32.17	40.27
1965	725.38	18.0	82.0	9.50	5.69	10.06	37.88	26.59	39.53
1966	745.42	17.9	81.1	8.83	5.59	9.47	35.05	20.85	36.71

Source: State Statistical Bureau, *Statistical Yearbook of China 1991*, Beijing: State Statistical Press, 1991, pp. 79–80.

[23] During discussions at a recent talk in Bangkok given by one of the authors, a senior official from the Food and Agricultural Organisation of the United Nations still would not believe that the famine actually occurred in China. In 1960, he had travelled for two weeks from the northeast to the south of China and did not observe the usual signs that he observed in the incidence of famine in other countries. However, his trips were restricted to cities, and he did not visit the rural areas.

thousand in 1959. Then it jumped to 25.43 per thousand in 1961. From the city and country figures, we see that much of the high national death rate could be traced to rural areas where there was an astonishing 28.58 per thousand death rate in 1960. In the famine period, city death rates were above normal standards but were much lower than rural rates. The opposite patterns are found in the birth statistics where the national rate dropped considerably in the years of crisis. Again, the rural population was more severely affected with the lowest birth rate of 16.99 per thousand occurred in 1961, which was about one half of the birth rate in 1957. Reduced births also seriously affected the well-being of the population. However, since these figures do not directly represent loss of lives, our analysis shall concentrate on death rates.

Table 3 provides more detailed death rates between 1954 and 1966 at the provincial level. Among the existing 30 provinces and municipalities, Hainan province and Tibet autonomous region are not included in the table because the former is a newly established province and the latter does not have official death rate records for the period under consideration. The data reveal variations of death rates during the crisis. In the worst famine year, 1960, the lowest death rates are found in the three municipalities, (1)Beijing, (2)Tianjin and (9)Shanghai, which were the most important political and industrial centres in China.[24] There are also noticeable regional variations in death rates: the north and northeast provinces generally suffered lower death tolls during the famine.

At this point, we note a few idiosyncratic factors that may cause variations in provincial death rates but will not be scrutinised in the later statistical analysis. First, the political strength of a provincial government to resist the central administration directly determined the volume of local grain extraction and consequently affected the severity of the famine. For instance, (19)Guangdong and (7)Jilin only had mild increases in excess deaths because these two provinces had been successful in reducing their grain export burdens. To the contrary, provinces that were cooperative or obedient to the state, such as (25)Gansu, (16)Henan, (21)Sichuan and (28)Hunan, all had high death rates. Personalities and political strategies of provincial leaders in weighing local welfare and central orders played a direct role in affecting the death rates.[25]

[24] The exception is (5)Neimonggu, which had a death rate below (2)Tianjin. Neimonggu is a special province because a high percentage of its population were herdsmen who primarily engaged in stock-raising activities. This province was also relatively isolated from the rest of the country.

[25] See Walker (1984) for an exhaustive analysis of China's grain supplies and procurement in the 1950s and 1960s and detailed descriptions about the political struggle between the provincial and central government. The general secretary of the Guangdong province, who effectively resisted the central procurement in the years of disasters, was purged during the Cultural Revolution. In other provinces, administrations managed to export 361 thousand tons of grain from Gansu, 935 thousand tons from Henan, 2.24 million tons from Sichuan, and 440 thousand tons from Hunan province despite the severe food shortages in 1959–60. These provinces were severely hit by famine. As early as the 1958–59 agricultural year, a procurement slogan was propagated in Sichuan: 'First the centre, then the locality; first external (commitments), then internal (commitments).' The province organised 5 million people to transport grain for export and the procurement reached the highest historical level of 2.595 million tons. Because of this, the massive famine hit the province earlier than elsewhere, resulting in a 47 per thousand death rate in 1959. The obedience of the provincial government was also responsible for the highest provincial death rate of 29.4 per thousand in 1961.

Table 3.

Death Rates of the Chinese Provinces: unit 0.1%

Province	1954	1955	1956	1957	1958	1959	1960	1961	1962	1963	1964	1965	1966
(1) Beijing*	8.6	9.5	7.7	8.2	8.1	9.7	9.1	10.8	8.8	8.1	8.3	6.8	7.2
(2) Tianjin*	9.3	9.9	8.8	9.4	8.7	9.9	10.3	9.9	7.4	7.3	7.8	6.2	6.9
(3) Hebei	12.1	11.6	11.3	11.3	10.9	12.3	15.8	13.6	9.1	11.2	10.9	8.7	8.7
(4) Shansi	14.7	12.9	11.6	12.7	11.7	12.8	14.2	12.2	11.3	11.4	14.0	10.4	10.3
(5) Neimonggu	20.9	11.4	7.9	10.5	7.9	11.0	9.4	8.8	9.0	8.5	11.8	9.3	8.1
(6) Lianing	8.6	9.4	6.6	9.4	6.6	11.8	11.5	17.5	8.5	7.9	9.3	7.1	6.2
(7) Jilin	10.4	9.9	7.5	9.1	9.1	13.4	10.1	12.0	10.0	9.4	12.6	9.7	8.6
(8) Heilongjing	11.1	11.3	10.1	10.5	9.2	12.8	10.6	11.1	8.6	8.6	11.5	8.0	7.4
(9) Shanghai*	7.1	8.1	6.8	6.0	5.9	6.9	6.8	7.7	7.3	7.0	6.1	5.7	5.3
(10) Jiangsu	12.2	11.8	13.0	10.3	9.4	14.6	18.4	13.4	10.4	9.0	10.1	9.5	8.1
(11) Zhejiang	13.4	12.6	9.5	9.3	9.2	10.8	11.9	9.8	8.6	7.9	9.2	8.1	7.1
(12) Anhui	16.6	11.8	14.3	9.1	12.3	16.7	68.6	8.1	8.2	7.9	8.6	7.2	7.1
(13) Fujian	10.9	8.9	8.4	7.9	7.5	7.9	15.3	11.9	8.3	7.4	8.6	7.3	7.1
(14) Jiangxi	14.2	16.2	12.5	11.5	11.3	13.0	16.1	11.5	11.0	9.8	10.9	9.4	8.5
(15) Shandong	11.7	13.7	12.1	12.1	12.8	18.2	23.6	18.4	12.4	11.8	12.0	10.2	9.9
(16) Henan	13.3	11.8	14.0	11.8	12.7	14.1	39.6	10.2	8.0	9.4	10.6	8.5	8.2
(17) Hubei	15.9	11.6	10.8	9.6	9.6	14.5	21.2	9.1	8.8	9.8	10.9	10.0	9.7
(18) Hunan	17.5	16.4	11.5	10.4	11.7	13.0	29.4	17.5	10.2	10.3	12.9	11.2	10.2
(19) Guangdong	11.2	10.6	11.1	8.4	9.2	11.1	15.2	10.8	9.4	7.6	8.3	6.8	6.4
(20) Guangxi	15.2	14.6	12.5	12.4	11.7	17.5	29.5	19.5	10.3	10.1	10.6	9.0	7.5
(21) Sichuan	8.4	9.2	10.4	12.1	25.2	47.0	54.0	29.4	14.6	12.8	13.9	11.5	10.8
(22) Guizhou	8.8	8.1	7.5	8.8	13.7	16.2	45.4	17.7	10.4	9.4	10.5	8.4	9.2
(23) Yunnan	16.7	13.7	15.2	16.3	21.6	18.0	26.3	11.8	10.9	14.1	15.2	13.0	10.8
(24) Shanxi	11.0	10.5	9.9	10.3	11.0	12.7	12.3	8.8	9.4	10.6	15.6	13.0	12.9
(25) Gansu	11.6	11.9	10.8	11.3	21.1	17.4	41.3	11.5	8.3	10.4	15.6	12.3	11.5
(26) Qinghai	13.3	14.1	9.4	10.4	13.0	16.6	40.7	11.7	5.4	8.4	15.5	9.1	9.8
(27) Ningxia	13.1	10.2	10.6	11.1	15.0	15.8	13.9	10.7	8.5	10.2	13.4	9.3	9.4
(28) Xinjiang	16.8	14.4	14.2	14.0	13.0	18.8	15.7	11.7	9.7	9.4	16.3	11.1	9.4
Nation	13.2	12.3	11.4	10.8	12.0	14.6	25.4	14.2	10.0	10.0	11.5	9.5	8.8

Note: Regional classification: North = (1)–(5), North-East = (6)–(7), East = (9)–(15), Centre-South = (16)–(21), South-West = (21)–(23) and North-West = (24)–(28).

Source: State Statistical Bureau.

Second, inter-provincial grain transfers to disaster regions or to regions with production concentration on industrial materials, such as cotton and forestry, are also important in understanding the variations in mortality rates. However, these transfers were often done on a very short-run basis and are not reflected in recorded data. This limitation prevents further investigation in this direction. Third, the nationwide lavish consumption of grain, which occurred at the end of 1958 and in early 1959 may partly explain interprovincial differences. Deluded by the good harvest in 1958, commune kitchens supplied grain to villagers without cost and caused enormous waste (Johnson, 1990). Since overconsumption occurred at different levels across provinces, its effect on the death rates in 1959 and 1960 was also different in different provinces.

3. Empirical Analysis

Data on 28 Chinese provinces for the period 1954–66 are used for empirical analysis. These data were collected by the State Statistical Bureau of China and were published in SSB (1990) and various volumes of the Chinese Statistical Yearbook. Recent demographic studies on China utilised these data and stressed the consistency of the information with other data sources (Banister, 1984; Coale, 1984; and Ashton *et al.*, 1984).

The rationale for analysing provincial death rates is discussed in Section 1. We choose this observation unit also because data at the provincial level in China are the most complete; the State Statistical Bureau has released voluminous province-level data to the public since the early 1980s; and these data are readily available. As explained in footnote 19, we choose 1954 as the starting year and 1966 as the ending year for empirical analysis because of data availability and distinctive historical periods.

3.1 *Empirical Hypotheses and Specification*

We consider urban bias and grain availability as the primary causes of the famine. The dependent variable for analysis is yearly provincial death rate for the 1954–66 period. The principal explanatory variables are the proportion of rural population in a province, a proxy for urban bias, and the per capita grain output in a province, a proxy for food availability. As explained in Section 1, we do not include property possessions and relative prices between food and other commodities as explanatory variables. This approach differs from Sen's analysis in a market setting where properties and relative prices were the basic ingredients for analysing famine.

The basic estimation equation is:

$$\ln \Delta_{it} = \beta_o + \beta_1 \ln E_{it} + \beta_2 D \ln E_{it} + \beta_3 \ln A_{it} + \beta_4 D \ln A_{it} + \boldsymbol{\beta}_5 \mathbf{Y}_t + \boldsymbol{\beta}_6 \mathbf{P}_i + \epsilon_{it} \quad (1)$$

where i indexes a province, t indexes a year, Δ_{it} is the death rate, E_{it} is the percentage of rural population, D is a dummy variable for the disaster years

(i.e., $D = 1$ for 1959, 1960, and 1961, and $D = 0$ for other years), A_{it} is the per capita grain output, $\mathbf{Y}_t$ and $\mathbf{P}_i$ are vectors of year and provincial dummies, and ϵ_{it} is a stochastic disturbance term. The interaction terms $D \ln E_{it}$ and $D \ln A_{it}$ allow urban bias and food availability to have differential effects on the observed death rates in normal years and disaster years. Since the variables are in logarithmic forms, the estimated parameters β will therefore represent elasticities. This formulation facilitates the calculation of observed percentage changes in provincial mortality rates resulting from percentage changes in the key explanatory variables.

The main hypotheses to be tested pertain to the relationship between provincial death rates and its two potential causes, urban bias ($\ln E_{it}$) and food availability ($\ln A_{it}$). In years with normal food production nationwide, we would expect the government to leave enough food to rural households. Consequently $\ln E_{it}$ would not have significant effect on the observed provincial death rates, that is, β_1 is expected not to be significantly different from zero. Moreover, if under nutrition was not a problem in the studied period, $\ln A_{it}$ would not have significant effect on the observed provincial death rates either, and β_3 is also expected not to be significantly different from zero. During the disaster years with severe grain shortages nationwide, however, the government's predominant concern was urban food supply. The higher the percentage of rural population within a province, the fewer protected rights to food people had. Therefore, we expect that a higher percentage of rural population in a province would result in a higher death rate in that province (that is, $(\beta_1 + \beta_2) > 0$). Similarly, given that there was a compulsory grain quota in each province and that the government did not have the ability to deliver relief to rural areas during the years with severe grain shortages nationwide, the food available for the rural population in a province depended on the food output in that province. A low *per capita* food supply in a province might reduce the availability of nutrients to below the subsistence level and result in hunger and deaths in the rural population.[26] Therefore, the observed death rates in a province in the disaster years are likely to be a negative function of $\ln A_{it}$ (that is, $(\beta_3 + \beta_4) < 0$).

The fixed effects specification in (1) assumes that certain characteristics unique to individual provinces and years can be captured by differences in the constant terms, causing shifts in provincial death rates. For instance, the quality of immunity services and health care continued to improve during the period of consideration, which may have resulted in continuous declines in death rates. The insertion of $\mathbf{Y}_t$ may account for this and other time-dependent effects. Similarly, the provincial dummy $\mathbf{P}_i$ may pick up regional effects on death rates, such as the behaviour of provincial leaders towards the central government, availability of medical services, differential income levels, trans-

[26] Changes in grain supply can affect the availability of net energy, protein and fat in a standard diet. See Piazza (1986) for analysis of the conversion of food to nutrition levels, which takes into account factors such as animal feed, agricultural seed and grain lost in processing and distribution. This paper does not systematically deal with the efficiency of food consumption and uses.

portation conditions, and other province-specific, time-invariant variables. Despite these reasons in favour of a fixed effects model, we do not pre-eliminate the feasibility of a random effect model. In the following analysis, we will use the Hausman-statistic to test the null hypothesis that a random effect model is more appropriate than a fixed effects specification. Our choice of the empirical function will be based on the specification test.

The basic specification in (1) is extended in two ways. First, we take into account the effect of grain carry-overs from the previous period. The issue of storage is important because it adds directly to the current grain output to give the total available food for consumption. Unfortunately, however, there are no data on the stock position of grain in China. To overcome this data deficiency, we use two-year moving averages of *per capita* grain output as an alternative availability measure.

The second extension allows the interaction of urban bias and availability with individual year dummies in the famine period. Previous analysis revealed that the size reduction in grain output, the directions of international trade, and the national death rates within the famine period exhibited noticeable changes. Additional time interactions facilitate an examination of within-period variations and therefore allow for a richer understanding of the actual situations.

It should be noted that this study does not systematically analyse the effect of epidemics on mortality rates. Famine-related diseases, such as cholera, malaria, fever, dysentery, and diarrhea, may cause additional deaths. Sen (1981*a*) documented that disease-related mortality usually persists for years subsequent to famines. In China, famine-related epidemics may not be an important cause of excess deaths. Table 3 provides evidence that mortality rates returned to normal in 1962, the year immediately after the crisis. In addition, we did not find any documentation on famine epidemics in China in the existing literature. Based on this information, we do not consider epidemics as a major cause of death during this famine.

For the two-way fixed effects model in (1), the formulation requires the two explanatory variables, namely the proportion of rural population and *per capita* grain output in a province, to vary beyond time effects and provincial effects. Otherwise, the model is not identified. Table 4 presents the means and standard deviations of these two variables for each year in the 1954–66 period. A quick perusal of these data suggests that there are variations for the variables both across provinces and over time, with the changes being especially large between the famine years and normal times. This observation is supported by the analysis of variance, which shows that 18% and 10% of the total variations in the proportion of rural population and in the *per capita* grain output are not explained by the regional and time dummies. There are indeed good reasons as to why the time and province effects fail to explain the full variations in the proportion of rural population. For one, such variations could be attributable to the differential pace of urbanisation in the provinces, which in turn was determined by the pace of industrialisation. In China, industrialisation was not a spontaneous process of economic development but heavily

Table 4.

Percentage of Rural Population and Per Capita Grain Output: Provincial Means and Standard Deviations

	Percentage of rural population		Per capita grain output	
Year	Mean	Standard deviation	Mean	Standard deviation
1954	79.16	21.76	291.05	95.16
1955	79.04	21.66	303.89	89.75
1956	78.69	20.96	306.81	94.07
1957	77.64	21.31	277.40	64.32
1958	76.62	17.92	293.20	94.26
1959	74.78	15.89	251.05	89.72
1960	74.04	16.08	208.74	61.83
1961	76.34	16.26	203.47	57.61
1962	78.76	15.99	219.76	59.10
1963	78.82	15.86	239.46	68.20
1964	79.11	15.68	258.77	65.30
1965	78.88	15.58	280.30	59.92
1966	78.81	15.55	281.92	73.99

Note: The figures are unweighted, arithmetic means of percentage of rural population and *per capita* grain output for the 28 provinces. Consequently, they differ from the national averages.

dependent upon state industrial investments. Initially in the 1950s, these investments were disproportionately concentrated in the northeastern and eastern provinces. As the fear of potential Sino-Soviet military conflicts along the borders of those provinces mounted, however, the state shifted these investments to the northwestern and southwestern provinces for national security reasons. At any rate, urbanisation rates were decidedly higher in provinces that received larger state industrial investments – an important factor accounting for variations in the ratio of rural to total population. For another, variations in population proportions among provinces were also likely to have been caused by the abrupt repatriation of millions of urban workers to their villages of origin during the famine (see footnote 21) because the total number of returned immigrants were likely to vary from one province to another. For variations in *per capita* grain output, the result from the analysis of variance should also be expected for the simple reason that fluctuations in grain output were unlikely to be the same magnitudes among the provinces, owing to weather and other idiosyncratic effects.

The consistence of a fixed effects estimator with a relatively short time period requires that the explanatory variables be strictly exogenous (Nickell, 1981). If rural-urban migration was unrestricted and individual farmers flee to the urban areas in droves as a result of food shortages, then the ratio of rural to total population during the famine period would become endogenous. In that case the strict exogeneity condition imposed upon the regression would be violated. Equation (1) includes an interaction term between the ratio of

rural population ($\ln E_{it}$) and the dummy for the famine years (D). If the strict exogeneity condition is violated for $\ln E_{it}$, the time period in D would be too short to ensure the fixed effects model an unbiased estimator. In fact, in most famines in other countries, rural people were free to flee to urban areas. However, in the case of 1959–61 famine in China, the government strictly controlled the rural-to-urban migration.[27] Even internal migration within rural areas was tightly controlled (Wang, *et al.*, 1989). Therefore, in our study, the proportion of rural population will not violate the strict exogeneity condition.

3.2 *Estimation Results*

Per capita grain output and its two-year moving averages are used as alternative availability measures. Applying one measure at a time, we estimate a set of two regressions that include the basic specification in (1) and the extension that allows the interactions of urban bias and availability with individual famine years. Provincial and time dummies are also included in each regression. Table 5 reports the estimation results and test statistics relating to these regression models.

The results of Hausman test, shown in the bottom of Table 5, reject the null hypotheses of random effects models in favour of the alternative fixed effects models. Groupwise heteroscedasticity is a potential problem in cross-section, time-series data. Greene (1993, pp. 395–6) suggests a likelihood ratio tests to examine the existence of groupwise heteroscedasticity. Under the null hypothesis of homoscedasticity, the likelihood ratio statistic is asymptotically distributed as chi-squared with $G-1$ degrees of freedom, where G represents the number of groups. All likelihood ratio statistics, shown in Table 5, reject the null hypothesis of homoscedasticity and favour the alternative hypothesis of groupwise heteroscedasticity. Therefore, the heteroscedasticity-consistent FGLS procedure, instead of OLS procedure, is used to fit the fixed effects regressions. The F-values in all regressions reject the possibility that the specified variables do not significantly explain variations in provincial death rates. Another result is that the estimated parameters and standard errors are very similar for using either *per capita* grain output or its two-year moving average as the availability measure. But the adjusted-R^2s are pairwise consistently higher if the moving averages are utilised. As such, our discussion will be based on the estimates using the moving averages as the availability measure, i.e. our discussions will concentrate on the results reported in Columns 3 and 4 in Table 5.

The focus of our analysis is on the assessment of the significance of urban bias and grain availability in causing inter-provincial excess deaths in the famine period. While the estimated coefficients for $\ln E_{it}$ and $\ln A_{it}$, reported in Table 5, are indicative of the effects in the normal period, the coefficients for $D\ln E_{it}$ and $D\ln A_{it}$ are not elasticities in the famine period. To derive the

[27] Evidence reported in footnote 23 is a result of stringent restrictions.

Table 5.

Fixed-effect Estimation of Provincial Death Rates

	Dependent variable = Ln(Provincial death rate (0.1%))			
	Ln A = Ln(per capita grain output)		Ln A = Ln(two-year moving averages of per capita grain output)	
Independent variables	FGLS (1)	FGLS (2)	FGLS (3)	FGLS (4)
Constant	1.373***	1.295***	1.344***	1.340***
	(0.374)	(0.358)	(0.377)	(0.359)
Ln E = Ln(% rural population)	0.031	0.027	0.020	0.013
	(0.052)	(0.044)	(0.054)	(0.042)
Ln $E \times D$ (famine period dummy)	0.584***	–	0.619***	–
	(0.107)		(0.105)	
Ln $E \times 1959$	–	0.267	–	0.249
		(0.143)		(0.138)
Ln $E \times 1960$	–	1.481***	–	1.472***
		(0.147)		(0.145)
Ln $E \times 1961$	–	0.090	–	0.139
		(0.162)		(0.159)
Ln A	−0.173	−0.211*	−0.191	−0.214*
	(0.096)	(0.087)	(0.111)	(0.101)
Ln $A \times D$ (Famine period dummy)	−0.228**	–	−0.279***	–
	(0.076)		(0.073)	
Ln $A \times 1959$	–	0.004	–	0.010
		(0.089)		(0.094)
Ln $A \times 1960$	–	−0.596***	–	0.614***
		(0.102)		(0.098)
Ln $A \times 1961$	–	(0.191)	–	−0.235*
		(0.121)		(0.116)
Provincial Dummy	Yes	Yes	Yes	Yes
Year Dummy	Yes	Yes	Yes	Yes
Hausman-Statistics:	35.88	61.31	34.08	66.06
H_0: Random effects model				
H_1: Fixed effects model				
Probability value of H_0	0.000	0.000	0.000	0.000
Log likelihood ratio test:	106.59	112.52	102.29	104.35
H_0: Homoscedasticity				
H_1: Groupwise heteroscedasticity				
Chi-squared (0.995, 28)	49.64	49.64	49.64	49.64
F-Statistics	14.43	15.44	14.66	15.74
Adjusted R^2	0.614	0.652	0.618	0.656

Note: Numbers in parentheses are standard errors. *, ** and *** denote statistical significance at the 5, 1, and 0.1% level, respectively.

appropriate effects on mortality during the disaster, we take the partial derivative of the dependent variable with respect to $\ln E_{it}$ or $\ln A_{it}$ and set $D = 1$, which is the sum of the coefficients with and without the interaction with D. For instance, the effect of urban bias on mortality during the famine from specification (3) is $(\beta_1 + \beta_2)$, that is $(0.02 + 0.619)$, and its variance is $\mathrm{Var}(\beta_1) + \mathrm{Var}(\beta_2) + 2\,\mathrm{Cov}(\beta_1, \beta_2)$. Consequently the estimates presented in Table 5 and the corresponding variance-covariance matrices contain sufficient information to compute all elasticities and their standard errors.

Table 6 presents the estimated elasticities for the effects of urban bias and grain availability with the moving-average specification. Column (1) contains the basic regression results that give support to the main hypothesis that both urban bias and food availability were important causes of famine in the disaster years. The estimated coefficient (β_1) for the proportion of rural population (Ln E) is not significantly different from zero, indicating that in normal years urban bias did not significantly affect provincial death rates. This result is consistent with the conjecture that the Chinese government left sufficient food to the rural population under normal supply conditions. When there was a negative supply shock, however, urban bias became an important explanation for famine deaths. The positive and highly significant coefficients ($\beta_1 + \beta_2$) for the disaster years imply that increases in the proportion of rural population led to higher provincial death rates. This result confirms our expectation because, unlike city residents, rural people did not have protected rights to food. Under adverse conditions, they suffered most of the negative consequences.

Results in Column (1) also reveal that the coefficient for *per capita* food availability (β_3) is negative but not statistically different from zero. In the famine period, however, variations in food supply did affect mortality. The negative and highly significant coefficient ($\beta_3 + \beta_4$) for *per capita* food availability in the famine period implies that increases in grain output in a province

Table 6.

Computed Effects of Entitlement Arrangements and Food Availability on Provincial Death Rates

Explanatory variables	(1)	(2)
Urban bias:		
Normal period (β_1)	0.020	0.013
	(0.054)	(0.042)
Famine period ($\beta_1 + \beta_2$)	0.639***	–
	(0.124)	
1959	–	0.262
		(0.149)
1960	–	1.485***
		(0.153)
1961	–	0.153
		(0.168)
Food availability:		
ln (two-year moving averages)		
Normal period (β_3)	−0.191	−0.214*
	(0.111)	(0.101)
Famine period ($\beta_3 + \beta_4$)	−0.470***	–
	(0.116)	
1959	–	−0.204
		(0.120)
1960	–	−0.827***
		(0.128)
1961	–	−0.449**
		(0.148)

Note: Numbers in parentheses are standard errors. *, **, *** denote statistical significance at the 5, 1, and 0.1% level, respectively.

reduced famine deaths for that province. This result also supports the theoretical conjecture.

Column (2) of Table 6 reports the results of interacting the urban bias and availability variables with individual famine year dummies. The estimated coefficients for ln E and ln A have the same signs as in Column (1). The coefficient for ln E is still positive and insignificant, further confirming the hypothesis that in normal years urban bias did not have much effect on death rate. However, the coefficient for ln A is negative and significantly different from zero at the 5% level. This result suggests that even in the normal years between 1954–66, food availability was an issue. The last column in Table 1 shows that the national average *per capita* grain availability was generally less than 300 kilograms in that period, which might not have a margin high enough to provide every resident with sufficient calories and other nutrition intakes. As a result, a moderate drop of availability in a province increased noticeably the death rate in that province even in the normal years.

The coefficients for urban bias interactions are all positive and those for availability interactions are all negative, supporting the proposed hypotheses. The estimates also reveal that the coefficients for 1960 are relatively large and highly significant. The coefficient for ln A for 1961 is significant but smaller, and the coefficients for both ln A and ln E for 1959 are statistically insignificant. What caused these within-period variations?

Several factors may have contributed to the revealed differences. First, grain output in China suddenly dropped by 15% in 1959. However, the availability situation in that year was relatively better than in 1960, when the output plunged again by another 15%. The grain availability in 1961 gradually recovered for three reasons: grain output increased by 4 million tons; the net export was reduced by about 7.2 million tons, and the national population decreased by about 3.48 million. At the national level, these changes resulted in a 8.5% increase in *per capita* grain availability in 1961. These considerations help to explain the results that availability and urban bias had their most significant effects in 1960.

A second set of factors that may explain the observed yearly variations are the efficiency of food consumption and government adjustment policies, an explanation related to the Darwinian conjecture. After the experience of massive starvation in 1960, people might adapt to severe situations by forming more efficient consumption habits, improving storage facilities, or discovering efficient substitutes for grain. These activities may have helped to reduce hunger and famine deaths. Government adjustment policies may also have helped to achieve the same end. Total procurement was dramatically reduced in 1961 (Table 1). The implications of all of these adaptive activities are consistent with the statistical findings that urban bias and availability effects were stronger in 1960. The various adjustments that were made in 1961 resulted in less starvation and reduced the importance of the two factors as determinants of excess deaths. This plausible physiological relationship is consistent with Lipton and Ravallion (1995), who found that food has higher value under scarcity.

4. Concluding Remarks

The food availability decline and Sen's entitlement theory are two leading approaches in understanding causes of famine. Previous research based on case studies has given independent support to each of these accounts. In this paper, we adopted the entitlement approach to analyse the Chinese famine of 1959–61 by assessing the significance of food availability and urban bias as famine causes. In the Chinese centrally planned system, the problems of food entitlement originated from policies biased in favour of urban residents, who were given the legal right to food through a rationing system. The peasantry, as food producers, were burdened with coercive quotas and were entitled only to the residual food supply. We chose province as the basic analytical unit not only because of data availability constraints but because each province had both a portion of the population guaranteed with food and obligations to meet a procurement target set by the central government.

Statistical analysis showed that during the severe supply shocks in 1959–61, both *per capita* grain output (an availability proxy) and percentage of rural population in a province (an urban bias proxy) are important determinants of the observed death rates in that province. Larger reductions in *per capita* grain supply caused more death tolls and a larger urban population resulted in fewer famine victims in the province.

To our knowledge, this paper is the first serious econometric study to assess the relative importance of famine causes using Sen's entitlement approach. It is also the first attempt to apply this approach to a famine in a centrally planned system. This endeavour is rewarding because some results from the Chinese famine may be generalised to other economic systems. Sen (1981*a*,*b*) documented that virtually all famine victims came from rural backgrounds in the famous historical famines. In addition, there was evidence of a 'food counter-movement' away from the famine-affected regions, and there were government policies that protected city food supplies. These observations and our analysis give supports to Sen's entitlement approach that, in addition to food availability, famine analysis should also give attention to rural-urban and institution-based policies. This paper has made some progress in this direction. Much is still unknown, and much needs to be discovered.[28]

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[28] The academic circle has started to pay attention to this famine. In the Allied Social Science Association Annual Meeting in Chicago in January 1998, there was a special session on this famine. The papers in that session will be published in a forthcoming issue of *China Economic Review*. There was another special session on this famine in the Allied Social Science Association Annual Meeting in New York in January 1999.

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