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Spatial and Structural Changes in Poverty Reduction in Bangladesh from 2000 to 2016: An Assessment

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Bangladesh has documented consistent reductions in poverty since 2000 and has also seen considerable transformation in the sector and location of economic activities. This paper exploits variation in sectoral growth and migration across districts and time to examine whether spatial variation in sectoral growth patterns—growth in agriculture, industry, or services—can explain spatial variation in poverty reduction, and what the role of migration was. We control for district fixed effects and instrument growth in agriculture and international migration to explore causal effects. We find that reductions in poverty were largest in places where agricultural output growth was highest and where industrial growth was highest. Poverty reduction was greater in districts which were sending larger numbers of international migrants. The relationship between agricultural growth and poverty reduction holds when instrumenting agricultural growth with rainfall data, and manufacturing growth has a significant impact on poverty reduction when proxied by a Bartik-style instrument, indicating that some of these findings are causal.

Keywords: Spatial Growth, Structural Change, Poverty
JEL Classification: R12, I30, I39, J43, J61

I. INTRODUCTION

Bangladesh has secured remarkable progress in reducing poverty since 2000. From 2000 to 2016, the proportion of the population living on less than the official upper poverty line has halved, falling from 49 to 24 per cent.[1] Education, health, and nutrition outcomes similarly saw substantial improvement.

Bangladesh has experienced high and consistent economic growth during this time, recording annual average per capita growth rates of 4.4 per cent from 2000

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[1] Official poverty estimates produced by the Bangladesh Bureau of Statistics (BBS) using the *Household Income and Expenditure Surveys* (HIESs).

to 2016,[2] driven largely by growth in industry. Growth in services has also been high, but growth in agriculture has been variable across this period.

Bangladesh has also seen the structure of its economy transform. In 2000, the share of the workforce that reported their main sector as agriculture was 64.8 per cent. By 2016, this had fallen to 41.1 per cent (International Labour Organisation estimates). The share of workers in industry doubled from 10.7 per cent in 2000 to 20.8 per cent in 2016, and the share of workers in services also grew, from 24.5 to 38 per cent. In addition to sectoral shifts, other large changes were occurring in the labour force during this time. Bangladesh urbanised from 20.3 per cent in 2000 to 28.1 per cent in 2016. And there has also been significant growth in the number of workers migrating internationally to work. In 2000, 223 thousand Bangladeshis migrated internationally to work, and this figure had grown to over 1 million by 2017 (Bangladesh Bureau of Manpower Employment and Training). Most migrants go to the Gulf countries, with Saudi Arabia and the United Arab Emirates (UAE) receiving an important share. As migration increased, so did remittances, from almost US$ 2 billion in 2000 to US$ 9 billion in 2016 (at 2000 prices, Bangladesh Bank).

This paper examines poverty reduction in Bangladesh to understand what aspects of the growth process during 2000 to 2016 drove the gains secured. In particular, the paper examines spatial variation in the sectoral nature of growth and how it impacted spatial differences in poverty reduction. It also examines the contribution of migration, both domestic and international, to reductions in poverty at the district level. The analysis in this paper exploits variation in poverty reduction, sectoral output growth, and migration across districts and time to examine what type of growth—output growth in agriculture, industry, or services—was more effective at reducing poverty.

The findings show that poverty fell fastest in places and periods when agricultural growth was strong and when manufacturing growth was high. Poverty reduction would have been much slower without either one of these engines of growth. Although the calculated elasticity of poverty to service sector growth is very similar to that for manufacturing growth, spatial variation in service sector growth does not explain differences in district poverty reduction. This could be because service sector growth tends to accompany growth in the other two sectors (agriculture and manufacturing). This would be consistent with Shilpi and Emran

[2] *World Development Indicators*.

(2016), who find that productivity shocks to agriculture also spur formalisation of the service sector.

These results reflect a causal relationship. Finding that poverty has fallen faster in places and times where agricultural growth has been stronger does not necessarily allow one to deduce that agricultural growth causes poverty reduction. Following Hill and Tsehaye (2018), we use weather data for each district in each year to instrument agricultural growth and try and identify whether the observed relationship between growth in agriculture and poverty reduction is causal. Results suggest it is. Additionally, when manufacturing growth is proxied by a Bartik instrument (Bartik 1991), it is significant.[3]

We also find that international migration provided opportunities for poverty reduction, with districts sending more migrants internationally seeing higher poverty reduction. It is hard to determine in what direction causality flows, as migration could be easier from districts that are more connected and better off. Equally, migration can reduce poverty by generating remittance flows and tightening rural labour markets. Efforts to disentangle these two effects were inconclusive.

Population growth net of in-migration is associated with faster poverty reduction, and in-migration is not correlated with poverty reduction. The positive correlation between population growth and poverty reduction could reflect the benefits of agglomeration, but equally it could reflect the fact that life expectancy increases at the same time as better levels of material wellbeing. The lack of beneficial effects from in-migration could reflect any benefits of agglomeration being outweighed by the fact that international migration often involves the movement of poorer individuals to wealthier places. Indeed, rates of internal migration are higher to better-off districts.

These findings fit into a literature that shows that growth in sectors from which poor households derive a considerable share of their income are more poverty reducing than growth in other sectors (Loayza and Raddatz 2010). Agricultural growth has been shown to be associated with stronger poverty reduction at the country level, followed by growth in services (Christiaensen, Demery and Kuhl 2011). Analysis of sub-national sectoral growth and poverty rates in China, Ethiopia, and India has documented that poverty has fallen faster in states and

[3] District manufacturing growth is given by the share of workers in the district in each subsector multiplied by the national growth rate in that sub-sector. District level poverty reduction is unlikely to influence national sub-sector growth rates, allowing this measure to reflect an exogenous source of growth to manufacturing in a district.

periods of high agricultural growth (Ravallion and Datt 1996, Hill and Tsehaye 2018, Montalvo and Ravallion 2009). In Brazil, similar analysis showed poverty reduction was faster in regions and periods where service sector growth was higher (Ferreira, Leite and Ravallion 2010). In Bangladesh, poor households are engaged in both agriculture and manufacturing through employment in labour-intensive light manufacturing. In addition, cross-country studies point out that international migration and remittances help reduce poverty in countries that send migrants (Adams and Page 2005, Gupta, Pattillo and Wagh 2009).

The findings are consistent with the extant literature on Bangladesh that has explored the determinants of poverty reduction and structural change over time. Previous poverty assessments documented the importance of growth in agriculture and manufacturing in driving poverty reduction (World Bank 2008, 2013). The important role of agricultural productivity growth in driving poverty reduction over the last two decades is also underscored by Gautam and Faruqee (2016), while Sen *et al*. (2014) show that differential rates of urbanisation and international migration can help explain the spatial pattern of poverty reduction across districts in Bangladesh. It is important to note that this literature also highlights the role that agriculture can play in spurring growth in other sectors. Gautam and Faruqee (2016) find that a 10 per cent increase in farm incomes generates an increase of 6 per cent in nonfarm incomes. Shilpi and Emran (2016) highlight the role of positive agricultural productivity shocks (driven by weather) in driving an increase in wages, as well as increased informal manufacturing and a formalisation of the service sector. The causal role that growth in one sector plays in spurring growth in other sectors is not considered in this paper.

In the next section, we discuss the data used in this report. In section III, we summarise trends in poverty reduction. Section IV outlines the empirical methodology used, and section V presents the main results. Section VI concludes.

II. DATA

Information on poverty, employment, agricultural growth, and migration was combined to build a district-level panel for the years 2000, 2005, 2010, and 2016. Bangladesh is divided into eight divisions, while each division is divided further into 64 districts (*zilas*), and each district is divided into sub-districts (*upazilas*). The panel was built at the district level, as this was the lowest level at which data on poverty, employment, and agricultural output could be disaggregated at multiple points in time for the period under consideration. The different sources of data used in the analysis are described next.

2.1 Poverty Estimates

The Household Income and Expenditure Survey (HIES) is a comprehensive, nationally representative survey used to measure monetary poverty in Bangladesh. The HIES 2016/17 is the fourth round in the series of HIES conducted by BBS in 2000, 2005, and 2010. Before 2000, BBS monitored poverty using a smaller survey that only collected data on expenditure, known as the Household Expenditure Survey (HES). Poverty estimates are based on total consumption per capita, which is generated from this data. The HIES was fielded during 2000, 2005, 2010, and from April 2016 to March 2017. (The latest HIES round will hereafter simply be referred to as 2016.)

The 2016 HIES was designed to provide representative poverty estimates at the district level.[4] However, in 2000, 2005, and 2010 the samples for the HIES were not designed to provide district-level estimates. They were intended to provide reliable annual poverty estimates for the country's divisions in urban and rural areas separately and for the Statistical Metropolitan Areas (SMAs). Small area estimation (SAE) was undertaken by the BBS in 2005 and 2010 to generate poverty estimates at the district and sub-district level. For this paper, SAE estimates were also generated for 2000.

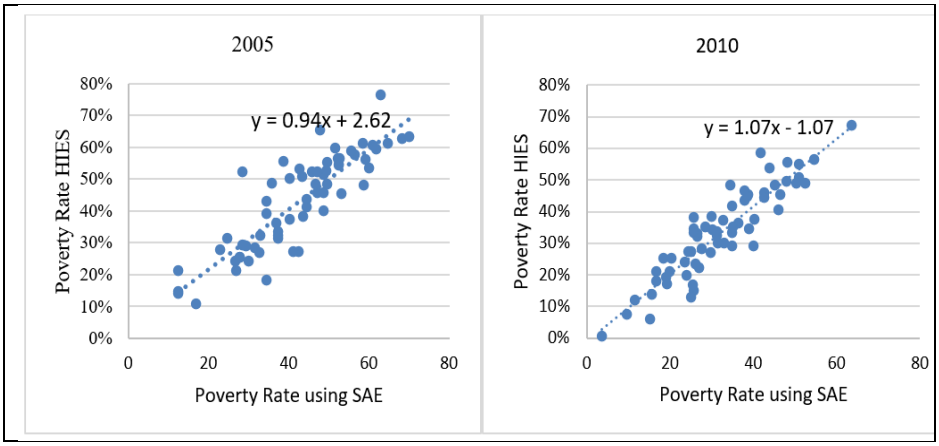
Even though the 2000, 2005, and 2010 HIES were not designed to provide district level poverty estimates, it is possible to generate poverty estimates at the district level from these samples as the PSUs cover all districts.[5] We compare district poverty estimates calculated directly from HIES to district poverty estimates from SAE in Figure 1. Estimates are presented for 2005 on the left and 2010 on the right. A linear regression line is displayed on both figures and shows that the correlation between the direct survey estimates and small area estimates is such that the line goes through the origin and has a coefficient that is not significantly different from 1. Most estimates lie along this line, although there are a few outliers. The survey-based estimates of poverty appear quite reliable, though the standard error on the estimates is sometimes quite high. The measurement error in the poverty estimates can be considered white noise, and poverty is the

[4] In 2016, a stratified, two-stage sample design was adopted for the HIES, with 2,304 Primary Sampling Units (PSUs) selected from the list of the *2011 Housing and Population Census* enumeration areas. PSUs in the HIES 2016/17 were allocated at the district level. Therefore, the sample was stratified at the district level. Since there were a total of 64 districts in Bangladesh, the sample design included a total of 132 sub-strata: 64 urban, 64 rural, and four main City Corporations (CCs). Within each PSU, 20 households were selected for interviews. The final sample size was 46,080 households (Ahmed *et al.* 2017).

[5] The one exception is Bandarban district in 2000.

dependent variable in our analysis. Given these facts, coefficient estimates will not be affected. We present results using both the small area estimates and the direct estimates as the dependent variable.

FIGURE 1: **Comparing Survey and Small Area Estimates (SAE) of District Poverty Rates, 2005 and 2010**



2.2 Sectoral Growth

Bangladesh does not produce subnational GDP estimates, so other data sources are used to generate proxies for district growth rates and the sectoral composition of growth. District level growth in a given period is estimated by multiplying the share of employment in the district in a given sector (agriculture, industry, or services) at the beginning of the period by the growth rate recorded by that sector nationally for the period. Identification of the impact of sectoral growth rates on poverty reduction in this estimation strategy comes from two sources: changes in the share of employment in a given sector over time and changes in the sectoral growth rate across time. The sectoral shares of employment are taken from the main sector of employment reported in the census (2000, 2010) and the expanded HIES (2016). Sectoral shares of employment for 2005 are interpolated between 2000 and 2010. For industry and service sector growth rates, it is possible to generate estimates using subsector employment and growth rates, given subsector growth rates are reported. These thus represent a Bartik instrument type of proxy for manufacturing and service sector growth. District level poverty reduction is unlikely to influence national sub-sector growth rates, allowing this measure to reflect an exogenous source of growth to manufacturing in a district.

2.3 Agricultural Output

Annual estimates of agricultural production are collected by BBS's agricultural wing. Data on area cultivated, total production, yield, and irrigation are collected for each crop in rice (Aman, Boro and Aus), wheat, jute and potato. Data on forest cover and fish production are also collected and published with the crop data in the *Annual Bulletin of Agricultural Statistics*. This data is available annually throughout this period. Data on agricultural wages paid to men and women at the district level are also collected and published in the *Bulletin of Agricultural Statistics*.

Data on rice prices were collected from the Department of Agricultural Marketing. We use monthly prices from up to 70 markets (at least one per district) for 2002, 2005, 2010, and 2016. The 2002 rice prices were deflated using the food CPI to be used as 2000 prices. The average price for each year across rice varieties was taken. Rice price data were combined with production data to estimate the value of rice production in each district. Rice is a large share of cropped area, and the share of land cultivated to rice stayed quite constant across time. The average of the district shares of total cropped area that was planted to rice was 73 per cent in 2000, 72 per cent in 2005, 75 per cent in 2010, and 72 per cent in 2016.

For jute, potato, wheat and fish production, wholesale prices at the division level for 2000, 2005, 2010, and 2016 were used to estimate the value of the production. These prices came from the same source as the crop estimates. For jute, there were two types of varieties, masta and tossa, and they were averaged. For potatoes, the prices available were for local and Holland variety, and they were also averaged. Wheat had only one wholesale price. Fish production was valued using Rui fish[6] prices. Data on forest cultivation were also calculated and was included in some regressions. There is no data on growth in livestock production.

2.4 Non-agricultural Growth

To create proxies for growth in non-agricultural sectors, the 2001/3 and 2013 economic censuses were used, as well as two censuses of firms larger than ten workers in 2006 and 2009 (Shilpi and Emran 2016). We use this data to create the number of firms and employees in 14 broad economic sectors.[7] Given that the 2006

[6] Rui fish is an expensive variety and represented less than 20 per cent of the catch in 2016, so a downward correction of a factor of ten was applied to the value of fish production, so that the ratio of value added from fish and value added from rice approximates that found in national accounts.

[7] 1. These were: Mining and Quarrying; 2. Manufacturing (without garment sector); 3. Manufacturing (only garment sector); 4. Construction; 5. Electricity, Gas, and Water

and 2009 data from the *Monitoring of Employment Survey* are for firms over ten employees, a scaling factor was created from the economic census to expand the 2006 and 2009 numbers. The ratio between firms over ten employees and firms under ten employees in 2013 was used to expand the 2006 and 2009 data. Using the data for 2001/3, 2006, 2009 and 2013, the values for 2000, 2005, 2010 and 2016 were linearly interpolated.

The total number of firms in the industry sector grew 163 per cent from 2000 to 2016, while in the service sector the growth rate was 175 per cent for the same period. The number of employees reported by the industry sector grew 195 per cent over the period, while the workforce reported by the service sector grew 173 per cent. It is important to note that, in 2000, 30 per cent of the workforce covered by the survey was in the industry sector. By 2016, that figure had increased to 50 per cent.

2.5 Migration

The international migration data come from the Bangladesh Bureau of Manpower Employment and Training. The number of people working overseas by district for 2004, 2005, 2006, 2007, and 2008 was taken from Islam (2014, 2015), while the total number of international migrants for 2005 and 2017 was obtained from the Ministry's webpage. This series is interpolated to provide international migration estimates for 2000, 2005, 2010 and 2016.

Within-country migration estimates were generated using the 1991, 2001, and 2011 censuses and the *Report on the Sample Vital Registration System* (SVRS) of 2016. Ideally, data on net migration at the district level would be available, however the only data available to us across time is the rate of in-migration to the district. The data is reported as the number of in-migrants for every 100 habitants in the census and for every 1,000 inhabitants in the SVRS by district. The 2000, 2005, and 2010 estimates were generated using linear interpolation of the census. For 2016, the SVRS estimates of in-migration at the division level and the national rural and urban breakdown were used to generate division and rural/urban growth rates. Those growth rates were then used to generate district level numbers for

Supply; 6. Wholesale and Retail; 7. Trade Transport, Storage, and Communications; 8. Hotels and Restaurants; 9. Banking, Insurance, and Financial Institutions; 10. Real Estate and Renting; 11. Public Administration and Defense; 12. Education; 13. Health and Social Work Community; and 14. Social and Personal Services.

2016 based on the division that the districts were in and their rural/urban share in 2010 and 2016.[8]

The change in population per district (measured as population density) is also included. Given that international migration and in-migration are controlled for, this can be thought of as proxying a combination of domestic out-migration and natural population increase.

In order to explore if the relation between migration and poverty reduction is causal, we instrument international migration using the destination country real GDP growth difference between periods. To determine which countries are relevant to Bangladesh international migration, we use HIES 2016, where the households report if they have an international migrant and in which country the migrant is living. This is used to generate district-level shares of migration destinations.[9] Ideally, we would have used the share of destinations at baseline in 2000, but this information was not available. For those countries in the list, we obtain the yearly real GDP growth estimates from the IMF WEO. Then, to create the instrument Z for the period t for district i, we use the sum over the countries c of the product of the share of migrants at the district level going to country c in 2016 $M_{2016\,c}$ times the country c growth rate differences[10] $(GDP_{tc} - GDP_{t-1c})$ for period t.

$$Z_{ti} = \sum_{c} (GDP_{tc} - GDP_{t-1c}) * M_{2016\,ic}$$

2.6 Weather Shocks

The rainfall data used is that used in Bandyopadhyay and Skoufias (2015). This data was obtained from the Climate Research Unit of the University of East Anglia (CRU). They provide an estimate of the monthly rainfall with half-degree resolution from 1902 to 2016. We use monthly data to create our estimates for each district for the four periods. To create the district level data, we generate the

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[8] $2010 - 2016\ migration\ growth\ rate\ for\ district\ i\ in\ division\ j =$
$[growth\ rural\ migration\ 10\ to\ 16 *\ share\ rural\ population\ i +$
$growth\ urban\ migration\ 10\ to\ 16 *\ share\ urban\ population\ i] * \left\{\frac{\frac{Division\ migration\ j\ 2016}{Division\ migration\ j\ 2010}}{\frac{National\ migration\ 2016}{National\ migration\ 2010}}\right\}$

[9] The list the most popular migration destinations in the 2016 HIES included: Australia, Brunei, Canada, Germany, Iran, Iraq, Italy, Japan, Republic of Korea, Kuwait, Libya, Malaysia, Mauritius, Oman, Qatar, Saudi Arabia, Singapore, South Africa, Sweden, Turkey, the United Arab Emirates, the United Kingdom, and the United States.

[10] For example, for the period 2000/2005, $GDP_{2000c} - GDP_{2005c}$

weighted average of the different pixels covering a district. In particular, we try to capture the difference in the amount of rain in the monsoon season (July to September). On average, 2016, 2010, and 2000 did not differ in rainfall, while 2005 was 11 per cent drier than 2000 and 13 per cent drier than 2010. The CRU estimates used are considered reliable, since they use not only data obtained from weather stations within Bangladesh itself, but also data from all the weather stations near the country.

III. TRENDS IN VARIABLES USED

Figures in Table I show that GDP growth and poverty reduction have been quite consistent since 2016, with growth at 5-6 per cent and the annual per cent reduction in poverty at around 4 per cent. Within this generally consistent picture, there has been an acceleration of the growth rate and, in recent years, a slowing of the pace of poverty reduction, which has resulted in a slightly lower growth-poverty elasticity. (Growth-poverty elasticity declined from -0.9 to -0.7 per cent reduction in poverty for every per cent of growth).

These shifts in growth and poverty reduction are in part the outcome of large changes in the structure of Bangladesh's economy, including sectors of work and patterns of residence. Agriculture fell from representing 24 per cent of GDP in 2000 to 15 per cent of GDP in 2016. Six percentage points of this shift went to industry and three percentage points to services. The structure of employment has shifted even more dramatically, with 24 per cent of the workforce moving out of agriculture during this period—roughly half into industry (10 per cent) and half into services (13 per cent). There was also a seven-percentage point increase in the share of the urban population between the two censuses taken during this period. The number of households reporting a household member working abroad has also risen.

The growth and shifts across sectors have not occurred uniformly during this time. Each of the three periods considered was quite different in terms of the type of growth and employment shifts observed. The first period (2000-2005) was a period of relatively low growth in agriculture; high but jobless growth in industry; and moderate, job-creating growth in services. The shift of employment from agriculture to services during this period was notable. The second period (2005-2010) was a time of high growth in agriculture, temporarily reducing departures from the agriculture sector (in contrast to the overall trend); high, job-creating

growth in industry; and very high but jobless growth in services. This period was notable for its very high agricultural growth and for the start of Bangladesh's boom in manufacturing job creation. The third period (2010-2016) marked a phase of lower agricultural growth; high, job-creating growth in manufacturing; and moderate service sector growth. High manufacturing growth with robust job creation was the period's most notable trait.

The poverty rate among households that derived their main employment from agriculture, industry, and services is detailed in Table I. It shows, on average, that the reduction in poverty has been faster among households in industry and services, except for 2005 to 2010, when poverty reduction among agricultural households was particularly high.

TABLE I

TRENDS IN KEY SECTORAL GDP, EMPLOYMENT, AND POVERTY VARIABLES, 2000-2016

	2001-5	2006-10	2011-16	2000	2005	2010	2016
Growth							
	Average per capita growth			*Share of GDP*			
Total GDP growth	5.1	6.1	6.5				
Total GDP per capita growth	3.3	4.8	5.2				
Agriculture	1.5	4.1	2.3	23.8	19.6	17.8	14.8
Industry	5.2	6.8	8.4	23.3	24.6	26.1	28.8
Services	2.3	8.4	4.9	52.9	55.8	56.0	56.5
Inflation	5.1	7.7	7.2				
Sector of employment and place of residence							
	Annual per cent change			*Share in employment (%)*			
Agriculture (ILO modeled estimate)	-1.3	-0.1	-0.8	64.8	48.1	47.3	41.1
Industry (ILO modeled estimate)	1.8	1.1	1.1	10.7	14.5	17.6	20.8
Services (ILO modeled estimate)	2.6	-0.3	0.5	24.5	37.4	35.0	38.0
Urban population (census)				23.6		30.4	
Poverty	*Annual per cent change*			*Poverty rate (%)*			
National (HIES)	-3.6	-4.2	-3.8	48.9	40.0	31.5	24.3
Agriculture (HIES)	-2.1	-6.2	-1.8	55.8	49.9	34.5	30.8
Industry (HIES)	-3.8	-3.0	-5.2	50.5	40.8	34.7	23.8
Services (HIES)	-3.6	-3.6	-4.0	39.3	32.3	26.4	20.1
Implied growth-poverty elasticity							
Total	-1.1	-0.9	-0.7				
Agriculture	-1.4	-1.5	-0.8				
Industry	-0.7	-0.4	-0.6				
Services	-1.6	-0.4	-0.8				

Note: Authors' estimations. HIES stands for the *Bangladesh Household Income and Expenditure Survey*. ILO stands for International Labour Organization. Poverty by sector of employment was calculated using the number of hours that a household worked in each sector. A household was considered to be in agriculture if the highest number of hours worked was devoted to agriculture.

Sectoral growth elasticities can be derived from the data on annual rates of poverty reduction and growth. The reduction in poverty among agricultural households for each percentage point increase in agricultural GDP was high from 2000 to 2010: every per cent of growth in agricultural value added per capita resulted in a 1.5 per cent reduction in poverty among agricultural households.

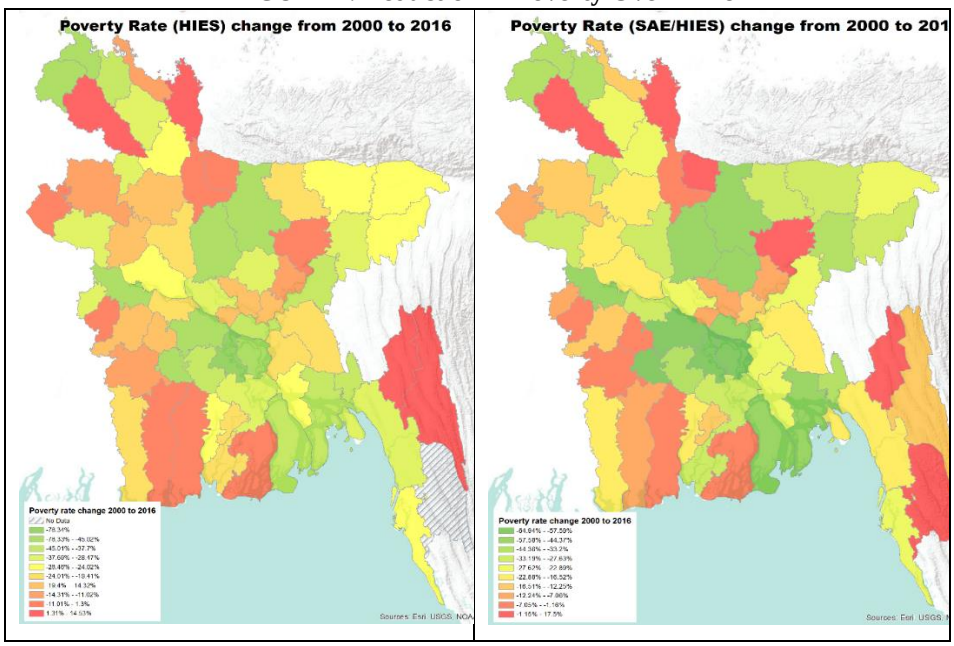
However, this elasticity was almost halved from 2010 to 2016, falling to 0.8. The elasticities have in general been lower for industry and services, around 0.4 to 0.8 across periods (except for the service sector from 2000 to 2005, which experienced a much higher elasticity). From 2010 to 2016, Bangladeshi households in the industry and service sectors secured 0.6 and 0.8 per cent reduction in poverty, respectively, for every per cent of value added per capita in these sectors.

Figure 2 shows that the reduction in poverty rates has not been uniform across space, with faster poverty reduction in the centre and northeast, compared to other parts of the country. Figure 3 shows the share of the population engaged in the three sectors across time. Agriculture (left) has had a downward trend across the board, with its strongest decline in the northeast. Industry (centre) has grown, with emphasis in the central part of the country. Services (right) has a mixed trend, with strong growth in the western portion of the country. These shifts are not uniformly spread across districts, and it is this spatial and temporal variation in the rate of poverty reduction and structural change that this paper exploits to assess what has driven poverty reduction from 2000 to 2016.

Table II presents the average of the district averages for each variable used in the analysis for 2000, 2005, 2010, and 2016. It shows the same trends as were depicted in Table I. The table shows the significant progress that Bangladesh has made in reducing poverty over time and indicates that this progress in poverty reduction has been commensurate with rapid growth in the value of rice and agricultural output per capita, the number of firms per capita (both industrial and services firms), and the level of international migration.

The average rates of district population growth and in-migration have also been increasing throughout this period. In-migration rates tend to be higher in less-poor districts. The district with the highest rate of in-migration is Dhaka (results for 2016 shown in Figure 4). Population growth net of in-migration is a combination of lack of out-migration, fertility rates, and life expectancy.

FIGURE 2. **Reduction in Poverty Over Time**



Note: Figures depict the change in the poverty rate between 2000 and 2006 in percentage points.

FIGURE 3: **Changes in Sectoral Shares of Population, 2000-2016**

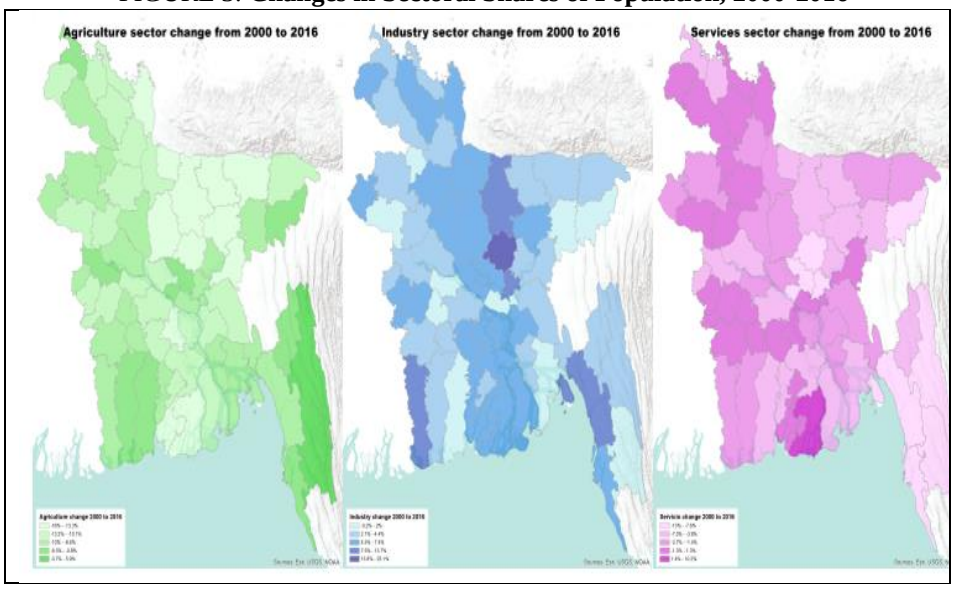


FIGURE 4: **Rates of In-migration in 2016 and Incidence of Lower Poverty in 2010**

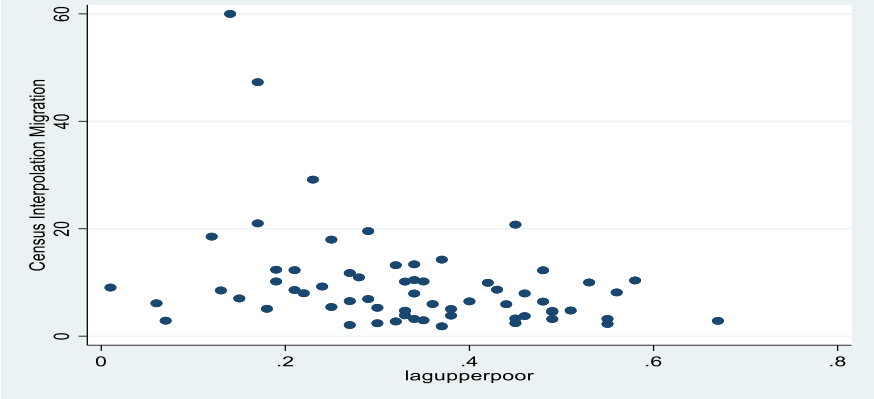


TABLE II

DISTRICT AVERAGES OF KEY VARIABLES

	Data source	2000	2005	2010	2016
Poverty headcount rate HIES	HIES	0.51	0.43	0.33	0.28
		(0.14)	(0.15)	(0.14)	(0.15)
Poverty headcount rate HIES and SAE	HIES	0.51	0.43	0.32	0.28
		(0.14)	(0.14)	(0.12)	(0.15)
Agricultural growth	BBS		1.9	3.1	1.9
			(0.4)	(0.7)	(0.5)
Industrial growth	Ec Census		0.4	0.6	1
			(0.3)	(0.5)	(0.9)
Services growth	Ec Census		1.9	2.1	2.0
			(0.5)	(0.6)	(0.5)
Aggregated growth	Ec Census, BBS		4.2	5.7	4.89
			(0.3)	(0.2)	(0.7)
Nominal rice value per capita (Taka p.c.)	BBS, DAM	262.3	335.3	808.8	776.5
		(103.7)	(130.5)	(334.8)	(331.6)
Fish value per capita (Taka p.c.)	BBS, DAM	374.6	397.5	610.5	383.8
		(217.2)	(224.5)	(436)	(300.2)
Agricultural value added per capita (Taka p.c.)	BBS, DAM	804.9	1146.1	3026.4	3444.1
		(535.2)	(902.4)	(2199.5)	(3022.8)
Real agricultural value added per capita (Taka p.c.)	BBS, DAM	2111.9	2364.7	3995.1	3174.0
		(1585)	(2049.9)	(3174.8)	(2975.6)
Industrial firms per capita	Ec Census	0.004	0.004	0.004	0.008
		(0.003)	(0.002)	(0.002)	(0.004)
Services firms per capita	Ec Census	0.029	0.024	0.032	0.061
		(0.007)	(0.011)	(0.014)	(0.021)
Irrigated area in thousands of acres	BBS	161.6	194.3	264.1	287.6
		(115.1)	(142.4)	(189.1)	(206.7)
Rainfall in Monsoon season (mm)	CRU	310.3	275	317.2	317.9
		(80.25)	(46.27)	(65.69)	(57.53)
Annual international migration as a share of initial population	BMET, Census		0.15	0.37	0.37
			(0.15)	(0.32)	(0.37)
Annual population growth net of in-migration	Census		1.14	1.08	1.38
			(0.68)	(0.71)	(0.68)
Annual in-migration as a share of initial population	Census		0.25	0.18	0.69
			(0.54)	(0.49)	(0.56)

Note: Staff own calculation. Numbers are unweighted district averages. p.c. stands for per capita. HIES stands for the *Bangladesh Household Income and Expenditure Survey*. SAE stands for small area estimation. BBS stands for Bangladesh Bureau of Statistics. Ec Census stands for Economic Census. DAM stands for the Bangladesh Department of Agriculture Marketing. BMET stands for Bangladesh Bureau of Manpower Employment and Training. CRU stands for Climate Research Unit, University of East Anglia. All real variables are expressed in 2016 prices. Standard errors are in parentheses.

IV. EMPIRICAL METHOD

The empirical approach we take is similar to that used in Ferreira, Leite and Ravallion (2010). We start by abstracting from the sectoral pattern of output growth and examining whether changes in poverty rates have been driven by aggregate output growth in the district. Specifically, we estimate:

$$\Delta \ln p_{zt} = \beta_0 + \beta_Y \Delta \ln Y_{zt} + u_z + e_{zt} \quad (1)$$

where p_{zt} is the poverty rate in the district z at time t, Y_{zt} is district growth, u_z is a district fixed effect, and e_{zt} is the error term. Y_{zt} is calculated by attributing the subsector growth rates to each district according to the share of the population engaged in that sector at the beginning of the period.

Secondly, we examine the relationship between the nature of sectoral output growth and poverty reduction by decomposing zonal output growth into that coming from agricultural growth and that coming from manufacturing and services. Following Ravallion and Datt (1996) and the subsequent literature on the relationship between the composition of growth and poverty reduction, we estimate:

$$\Delta \ln p_{zt} = \beta_0 + \beta_{Y^a} s^a_{zt-1} \Delta \ln Y^a_{zt} + \beta_{Y^m} s^m_{zt-1} \Delta \ln Y^m_{zt} + \beta_{Y^r} s^r_{zt-1} \Delta \ln Y^r_{zt} + u_z + e_{zt} \quad (2)$$

where $Y^i_{zt}, i = a, m, r$ is the output of agriculture (a), manufacturing (m), and services (r), respectively, and s^i_{zt-1} is the share of output of sector i at the beginning of the period. Interacting the rate of growth of sector i with the share of sector i in total output allows growth in a given sector to influence poverty according to the size of the sector. The combined expression, $\beta_{Y^i} s^i_{zt-1}$, provides a measure of the elasticity of poverty to growth in that sector. This specification allows us to look at whether particular components of growth are more strongly associated with poverty reduction, and whether the sectoral composition of growth matters (Ferreira, Leite and Ravallion 2010).

This specification allows us to control for a number of other factors that might confound the relationship between sectoral composition and poverty rates. The regression is estimated in differences, allowing us to control for any initial district characteristics that affect the relationship between the output of one sector and poverty.[11] District-specific time trends are included in the model, u_z, through the

[11] Annualized growth rates are calculated for each variable by dividing each growth rate by the number of years over which the growth occurred.

inclusion of district-specific fixed effects. This allows each district to have a district-specific trend in poverty reduction over the period.

A second set of regressions is then run, in which variables capturing migration are included. Specifically, the following regression is run:

$$\Delta \ln p_{zt} = \beta_0 + \beta_{Y^a} s^a_{zt-1} \Delta \ln Y^a_{zt} + \beta_{Y^m} s^m_{zt-1} \Delta \ln Y^m_{zt} + \beta_{Y^r} s^r_{zt-1} \Delta \ln Y^r_{zt}$$
$$\beta_m m_{zt} + \beta_c c_{zt} + \beta_{intl} intl_{zt} + u_z + e_{zt} \quad (3)$$

where m_{zt} is in-migration to the district, c_{zt} is population density, and $intl_{zt}$ is international migration.

Even with district fixed effects, our estimation strategy is subject to a concern that reverse causation may be driving the results. For us to argue that growth in agriculture caused poverty reduction, we will need to be able to address the argument that gains in poverty reduction might have caused greater agricultural growth. In some papers on the relationship between sectoral growth and poverty, this goes unaddressed, and in other papers it is addressed by instrumenting growth rates with growth rates of neighbours (Ligon and Sadoulet 2008, Loayza and Raddatz 2010), lagged growth (Loayza and Raddatz 2010), or rainfall (Hill and Tsehaye 2018). We use rainfall shocks interacted with changes to the international price of rice as an estimate of exogenous variation in agricultural growth. It is not clear what could be used to instrument for manufacturing growth, so this is not attempted. International migration is instrumented with the weighted average growth rate in countries to which migrants from that district migrate, where the weights indicate the share of migrants from the district to a given country.

V. RESULTS

5.1 Growth and Poverty Reduction

Growth has been a significant driver of reductions in poverty in Bangladesh. First, we examine the relationship between poverty reduction and total output growth per capita by estimating equation 1. The results are presented in columns 1-2 of Table III and indicate that the elasticity of poverty to growth is -2.5. For every 1 per cent of growth, poverty fell by 2.5 per cent.

Poverty reduction has been faster in districts and periods where agricultural growth and manufacturing growth have been higher, in particular manufacturing growth. The relationship between the nature of growth and poverty reduction is examined by estimating equation 2 (Table III, columns 3-4). The coefficient on agriculture and manufacturing growth is similar, but it implies a much higher elasticity of growth for agriculture than for manufacturing, given that the

coefficients in Table II are for sectoral growth multiplied by the share of the sector in district employment. The implied elasticities are given in Table IV, alongside the average elasticities for 2000-2016 calculated from GDP growth data and sectoral poverty rates.

Services encompass many different types of activities, and in column 4 services are split into service sectors that are dominated by high-skill employees (the "FIRE" sectors of finance, insurance, real-estate, and education) and other services. However, this does not change the insignificance of the service sector. In columns 5 to 8 of Table III, growth in the value of agricultural production is used to proxy output growth. In columns 5 and 6, the subsector employment shares and growth rates are used to construct a district measure of output growth in industry and services. In columns 7 and 8, growth in the number of firms in industry and services is used to proxy output growth in industry and services. The results are the same (although the coefficients change, given the different magnitudes of the underlying variables). The results in column 8 show that growth in garment industries did not have an additional impact not captured by this measure of manufacturing growth.

TABLE III

SECTORAL GROWTH AND RATE OF POVERTY REDUCTION: RESULTS OF MULTIVARIATE ANALYSIS WITH DISTRICT LEVEL DATA

Dependent variable: Change in poverty rate at the district level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Using growth in the value of agricultural production for agricultural growth			
					Using subsector employment shares and growth rates for non-agricultural growth		Using growth in number of firms for non-agricultural growth	
Total growth per capita	-0.0253*	-0.0274**						
	(0.0151)	(0.0123)						
Growth in								
Agriculture			-0.127	-0.129**	-0.717*	-0.749**	-0.683*	-0.669*
			(0.0791)	(0.0637)	(0.382)	(0.369)	(0.347)	(0.352)
Manufacturing			-0.114***	-0.117***	-0.0488*	-0.0453*	-3.607**	-3.123*
			(0.0435)	(0.0350)	(0.0291)	(0.0273)	(1.449)	(1.865)
Services			-0.0487	-0.0741	0.00827		-0.0424	-0.0958
			(0.0977)	(0.0772)	(0.0540)		(0.312)	(0.326)
FIRE						0.0002		
						(0.0006)		
Other services						0.0004		
						(0.0005)		
Garments								-0.0077
								(0.015)
Observations	191	192	191	192	191	191	191	191
R-squared	0.022	0.038	0.068	0.099	0.048	0.053	0.073	0.076
Data on poverty	HIES	SAE	HIES	SAE	HIES	HIES	HIES	HIES
Number of districts	64	64	64	64	64	64	64	64

Note: The dependent variable is the annualized percentage change in the district poverty rate estimated directly from the HIES. Results in column 2 and 4 use small area estimation (SAE). FIRE stands for Finance, Insurance, Real Estate and Education. District fixed effects included but not shown. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Agricultural growth is perhaps more likely to bring about growth in rural areas and manufacturing growth is perhaps more likely to bring about reductions in poverty in urban centres. The districts in this study include both rural and urban areas; however this is tested by re-estimating equation 2, this time weighting the results by the proportion of the district that is urban. In this specification, those districts with very small urban populations are given a low weight, and those that are entirely urban derive the highest weight. In this specification, we would expect that sources of growth that are more important to urban poverty reduction would appear more significant. Coefficients are very similar when this is done, and the results are not shown.

TABLE IV

CALCULATED AND ESTIMATED ELASTICITIES OF POVERTY WITH RESPECT TO SECTORAL GROWTH

	Average over 2000-2016 calculated from Table I	Elasticities backed out of estimates from Table III, columns 2 and 4
Total growth	-0.9	-1.0
Agriculture growth	-1.2	-2.7
Industrial growth	-0.6	-0.4
Service sector growth	-0.9	-1.0

Source: Estimated from Tables I and III.

Table V presents the same regressions as in Table III, but using as dependent variables the average consumption growth rate and the average consumption growth rate of the bottom 40 per cent of the consumption distribution in a given district. The results show some interesting differences. Agricultural growth is important for consumption growth among the bottom 40 per cent, but not average consumption growth in general. Manufacturing growth is important for consumption growth across the distribution, although it becomes insignificant in some specifications. Service sector growth emerges as weakly important for the consumption growth of the bottom 40 per cent in some specifications.

TABLE V

SECTORAL GROWTH AND CONSUMPTION GROWTH OF THE BOTTOM 40 PER CENT: RESULTS OF MULTIVARIATE ANALYSIS WITH DISTRICT LEVEL DATA

Dependent variable: Change in log of consumption

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
					Using growth in the value of agricultural production for agricultural growth			
					Using subsector employment shares and growth rates for non-agricultural growth		Using growth in number of firms for non-agricultural growth	
Total growth per capita	0.0440***	0.0482***						
	(0.00529)	(0.00479)						
Growth in								
Agriculture			0.0238	0.0396*	0.729***	0.776***	0.802***	0.896***
			(0.0262)	(0.0230)	(0.150)	(0.140)	(0.136)	(0.127)
Manufacturing			0.0251*	0.0283**	0.0124	0.0154	0.424	0.677
			(0.0144)	(0.0126)	(0.0114)	(0.0106)	(0.569)	(0.529)
Services			0.00595	0.0212	0.0244	0.0378*	0.201	0.216*
			(0.0324)	(0.0284)	(0.0212)	(0.0197)	(0.122)	(0.114)
Observations	191	192	191	192	191	191	191	191
R-squared	0.355	0.446	0.450	0.556	0.213	0.283	0.231	0.304
Consumption growth of:	All	B40	All	B40	All	B40	All	B40
Number of districts	64	64	64	64	64	64	64	64

Note: The dependent variable is the log of consumption growth for all households in the district or the bottom 40 per cent, as indicated. This variable is estimated directly from the HIES. District fixed effects included but not shown. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

5.2 Migration and Poverty Reduction

In Table VI, we allow for changes in population in the district to impact growth rates, conditional on the nature of economic growth in the district. Specifically, we examine the relationship between poverty reduction and rates of international migration, in-migration, and population growth net of in-migration, controlling for sectoral growth rates. Sectoral growth rates in manufacturing and services are proxied using weighted averages of sectoral growth rates in column 1 and the growth in the number of firms in services and industry in the district in column 2.

TABLE VI

MIGRATION AND POVERTY REDUCTION

Dependent variable: Change in poverty rate at the district level

	(1) Using subsector growth rates in manufacturing and services	(2) Using growth in number of firms in manufacturing and services
Growth in agricultural value added	-1.085**	-0.715
	(0.440)	(0.432)
Manufacturing growth	-0.0793***	-3.719***
	(0.0297)	(1.416)
Service sector growth	0.00768	-0.393
	(0.0580)	(0.339)
Annual international migration	17.26***	17.36***
	(6.387)	(6.370)
Annual population growth (net of in-migration)	-6.478**	-3.114
	(2.925)	(2.851)
Annual in-migration	1.803	3.427
	(4.149)	(3.963)
Constant	0.0193	-0.0495
	(0.156)	(0.0436)
Observations	187	187
R-squared	0.134	0.144
Number of districts	64	64

Note: The dependent variable is the annualized percentage change in the district poverty rate estimated directly from the HIES. District and time fixed effects included but not shown. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1

The results suggest international migration may have had a powerful role in reducing poverty in Bangladesh. For each additional 0.1 per cent of the population migrating, poverty in the district fell by 1.7 per cent. This is a very large effect. The number of remittance recipients is unlikely to be 17 for each migrant, so this either indicates very large indirect benefits from international migration or substantial reverse causality with international migration flowing more from places that were reducing poverty for other reasons. This is something that we

explore in the following section, instrumenting migration with growth rates of recipient countries.

Higher non-migration population growth is also positively correlated with poverty reduction, although the results are less consistently significant. In one specification, an increase in population growth net of in-migration of 0.1 per cent is correlated with poverty reduction that is 0.6 per cent faster. The correlation between non-migration population growth and poverty reduction could also reflect different relationships at play. It could reflect the benefits of agglomeration, or it could reflect the fact that places with higher population growth were likely places where improvements in life expectancy had been large. These improvements in life expectancy are in themselves another reflection of improvements in wellbeing. There was no impact of population growth from in-migration on poverty, perhaps indicating that the fact that households tend to move to better-off districts (presumably from poorer ones) offsets some of the gains in agglomeration that would otherwise have resulted from the population growth in-migration brings. However, given that in-migration likely reduces the poverty of those moving, the overall impact of domestic migration on national poverty reduction could be positive. We are unable to test this, as we do not have information on out-migration at the district level.

5.3 Instrumental Variable Results

None of the relationships presented in Tables III, V, and VI are causal, even though district and year fixed effects are included. Instruments cannot be identified for all the variables examined here, but we examine instruments for agricultural growth (rainfall) and international migration (Bartik instrument using growth rates in destination countries). Table VII shows how agricultural production has been increasing in the irrigated area of the district, but that nevertheless rainfall shocks do impact agricultural value added, most likely because production during the main summer season tends not to be irrigated.

Results instrumenting for agricultural growth and migration are presented in Table VIII. When agricultural value added is instrumented with rainfall, it is still significant in predicting poverty reduction within the district. However, this no longer holds when year fixed effects are included. The instrumented results for international migration are less clear. The first-stage results show the Bartik

instrument is significant, but it has the opposite sign from what one would expect, with higher growth rates in receiving countries reducing the likelihood of international migration from the district. International migration is no longer significant when instrumented with this instrument. In case this non-result arises because the IV regression results lack power, results are also presented replacing district fixed effects with division fixed effects in columns 5 to 7. This does not impact the significance of the instrumented international migration variable. In column 7, we instrument for both at the same time, and the results remain unchanged.

TABLE VII

THE RELATIONSHIP BETWEEN AGRICULTURAL GROWTH, IRRIGATION, AND RAINFALL OVER TIME

Dependent variable: Growth in agricultural value added

	(1)
Irrigated area	7.926***
	(1.769)
Average monthly rainfall	6.138*
	(3.395)
Maximum monthly rainfall	-3.536**
	(1.397)
Thailand price of rice	0.417***
	(0.140)
Constant	-108.2*
	(809.9)
Observations	256
R-squared	0.1237
Number of districts	64

Note: District fixed effects included but not shown. Standard errors are in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

TABLE VIII
INSTRUMENTING AGRICULTURAL GROWTH AND INTERNATIONAL MIGRATION
Dependent variable: Change in poverty rate at the district level

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Growth in agricultural value added	-1.969*	-0.694*	-1.775**	-0.436	-1.969*	-0.694*	-0.690**
	(1.014)	(0.368)	(0.833)	(0.360)	(1.014)	(0.368)	(0.344)
Growth in the number of firms in manufacturing	-4.426***	-4.111**	-4.536***	-4.384**	-4.426***	-4.111**	-3.911***
	(1.642)	(2.083)	(1.353)	(2.048)	(1.642)	(2.083)	(1.448)
Growth in the number of firms in services	-0.0518	-0.765	-0.0939	-1.024	-0.0518	-0.765	-0.475
	(0.329)	(2.083)	(0.275)	(2.029)	(0.329)	(2.083)	(0.423)
Growth in international migration		44.19		58.56		44.19	26.18
		(127.8)		(124.5)		(127.8)	(17.91)
Observations	191	184	192	185	191	184	184
Number of districts	64	63	64	63	64	63	63
Fixed effects	District	District	District	District	Division	Division	Division
Data on poverty	HIES	HIES	SAE	SAE	HIES	HIES	HIES
Instrumenting	Ag growth	Migration	Ag growth	Migration	Ag growth	Migration	Migration Ag growth

Note: The dependent variable is the annualized percentage change in the district poverty rate estimated directly from the HIES or using small area estimation (SAE). District fixed effects included but not shown. Standard errors are in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

VI. CONCLUSION

This paper has examined poverty reduction in Bangladesh from 2000 to 2016, to understand what aspects of growth and changes in employment drove the gains secured. The findings show that growth in agriculture and growth in manufacturing have been equally important parts of Bangladesh's poverty reduction record. Poverty fell faster in districts and time periods when growth in the value of agricultural output and the number of manufacturing firms was the highest. The results also show the important role that international migration may have played in securing welfare gains in sending districts.

A key question is whether the drivers of agricultural and manufacturing growth can be sustained going forward, and whether this growth can continue to benefit poor households: agricultural growth increases wages and returns to assets for poor households, and manufacturing jobs create unskilled employment. The results suggest that it is also important to examine how to sustain the flow of international migrants and remittances, given the important role this has played in poverty reduction.

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ANNEX

District Poverty Rates

Poverty Rate (HIES direct estimates)				
District	2000	2005	2010	2016
Bagerhat	33.0	46.0	42.8	31.0
Bandarban		64.7	40.1	63.2
Barguna	49.0	60.9	19.0	25.7
Barisal	61.0	60.1	54.8	27.4
Bhola	54.0	48.9	33.2	15.5
Bogra	42.0	47.3	16.6	27.2
Brahmanbaria	51.0	37.1	30.0	10.3
Chandpur	50.0	28.7	51.0	29.3
Chittagong	44.0	26.7	11.5	13.7
Chuadanga	36.0	33.0	27.7	31.9
Comilla	36.0	30.1	37.9	13.5
Cox's bazar	42.0	51.7	32.7	16.6
Dhaka	26.0	16.9	15.7	10.0
Dinajpur	55.0	49.8	37.9	64.3
Faridpur	55.0	44.7	36.3	7.7
Feni	52.0	12.5	25.9	8.1
Gaibandha	71.0	52.5	48.0	46.7
Gazipur	38.0	37.4	19.4	6.9
Gopalganj	71.0	42.4	42.7	29.5
Habiganj	42.0	46.9	25.3	13.4
Joypurhat	52.0	43.7	26.7	21.4
Jamalpur	58.0	58.7	51.1	52.5
Jessore	38.0	56.6	39.0	26.9
Jhalokati	42.0	47.1	40.5	21.6
Jhenaidah	41.0	35.8	24.7	26.5
Khagrachhari	49.0	37.3	25.5	52.7
Khulna	38.0	53.0	38.8	30.8
Kishoreganj	59.0	24.8	30.3	53.5
Kurigram	60.0	68.2	63.7	70.8
Kushtia	70.0	27.8	3.6	17.5
Lakshmipur	58.0	34.7	31.2	32.5
Lalmonirhat	53.0	53.2	34.5	42.0
Madaripur	82.0	38.7	34.9	3.7
Magura	71.0	28.7	45.4	56.7
Manikganj	60.0	37.4	18.5	30.7
Meherpur	60.0	12.4	15.2	31.5
Maulvibazar	36.0	29.5	25.7	11.0
Munshiganj	43.0	27.2	28.7	3.1
Mymensingh	68.0	58.9	50.5	22.0

(Contd. Annex)

Poverty Rate (HIES direct estimates)				
District	2000	2005	2010	2016
Naogaon	45.0	48.7	16.9	32.2
Poverty Rate (HIES direct estimates)				
District	2000	2005	2010	2016
Narail	63.0	44.6	20.0	16.8
Narayanganj	19.0	23.1	26.1	2.6
Narsingdi	22.0	34.7	23.7	10.5
Natore	40.0	49.7	35.1	24.0
Nawabganj	43.0	42.7	25.3	39.7
Netrakona	57.0	31.7	35.3	34.0
Nilphamari	70.0	70.2	34.8	32.3
Noakhali	62.0	34.5	9.6	23.3
Pabna	57.0	49.3	31.5	33.0
Panchagarh	75.0	55.9	26.7	26.4
Patuakhali	42.0	63.0	25.8	37.2
Pirojpur	59.0	27.9	44.1	32.2
Rajshahi	50.0	41.3	31.4	20.2
Rajbari	57.0	43.4	41.9	33.8
Rangamati	14.0	40.2	20.3	28.5
Rangpur	73.0	61.9	46.2	43.8
Shariatpur	74.0	32.9	52.6	15.7
Satkhira	38.0	59.1	46.3	18.6
Sirajganj	52.0	52.7	38.7	30.5
Sherpur	40.0	47.9	48.4	41.3
Sunamganj	52.0	48.8	26.0	26.0
Sylhet	39.0	12.5	24.1	13.0
Tangail	64.0	40.4	29.7	19.0
Thakurgaon	72.0	52.2	27.0	23.5