Decentralization's effects on education, health and agriculture outcomes, and on distribution: Evidence from Ethiopia

Qaiser Khan[1]
Jean-Paul Faguet[2]
Christopher Gaukler[3]
Wendmsyamregne Mekasha[4]

15 June 2014

Abstract

Decentralization is meant to improve public services, but relatively few studies examine this question empirically. We explore the effects of decentralization on education, health and agriculture outcomes in Ethiopia using an original database covering all of the country's *woredas* (i.e. local governments), which will itself eventually be an important contribution of this paper. Ethiopia is an interesting case study for two big reasons: (i) It is the fastest growing country in Africa and one of the 5 fastest-growing in the world; and (ii) Since decentralizing the country has made significant progress towards its MDGs and in reducing poverty. We show that decentralization improved net enrolments in education, access to basic services in health such as antenatal care, contraception, vaccination rates, and deliveries by skilled birth attendants, and contributed to greater agricultural productivity in cereals, vegetables, enset, coffee and fruits.

Keywords: decentralization, education, health, agriculture, public investment, Ethiopia, local government

JEL: H41, H75, H77, 01

[1] Ethiopia Country Office, World Bank, Africa Avenue (Bole Road), Addis Ababa.
[2] Department of International Development and STICERD, London School of Economics, Houghton Street, London WC2A 2AE, UK, +44-20-7955-6435 (o), 7955-6844 (f), j.p.faguet@lse.ac.uk (contact author)
[3] Ethiopia Country Office, World Bank, Africa Avenue (Bole Road), Addis Ababa.
[4] Ethiopia Country Office, World Bank, Africa Avenue (Bole Road), Addis Ababa.

1. Introduction

With 90 million inhabitants, 90+ ethnic and linguistic groups, and a sustained growth rate of over 10% in recent years, Ethiopia is a big, diverse, important developing country. The country's social and geographic diversity, combined with a federal structure and sincere decentralization[5] pursued since the early 1990s, make it an ideal context in which to study the effects of decentralization on social services and outcomes in key sectors such as education, health and agriculture, as well as their distribution. This paper does so with an original database of *woreda* (read "municipal") economic, social and demographic characteristics that the authors painstakingly constructed from official sources.

The evidence that Ethiopia can offer is especially welcome in light of the inconclusive nature of the empirical evidence accumulated over the past four decades. This is especially true of the older decentralization literature from the 1960s-1990s. Consider the broadest surveys of that work. Rondinelli, Cheema and Nellis (1983) note that decentralization has usually disappointed its partisans. Most developing countries implementing decentralization experienced serious administrative problems. Although few comprehensive evaluations of the benefits and costs of decentralization efforts have been conducted, those that were attempted indicate limited success in some countries but not others. A decade and a half later, surveys by Piriou-Sall (1998), Manor (1999) and Smoke (2001) are slightly more positive, but with caveats about the strength of the evidence in decentralization's favor. Manor notes that the evidence, though extensive, is still incomplete, but ends his study with the opinion that 'while decentralization …is no panacea, it has many virtues and is worth pursuing'. Smoke, by contrast, finds the evidence

[5] Sincere decentralization is defined as reform that effectively devolves power and resources from central to subnational levels of government, as opposed to insincere reforms that leave power resources at the center. For a more detailed discussion, see Faguet (2012).

mixed and anecdotal, and asks whether there is empirical justification for pursuing decentralization at all. Given the sheer size of this literature, the lack of progress is surprising.

By contrast, more recent empirical studies distinguish themselves in two important ways: (i) They are often technically more sophisticated than the older, more case-study based literature, as developing-country datasets have improved enormously over recent decades; and (ii) They are generally more positive about decentralization's potential. Only five recent studies that we know of address the link between decentralization and substantive outcomes directly and with rigorous quantitative evidence. These include Escaleras and Register (2012), who find that fiscal decentralization is associated with lower natural disaster death rates, implying more effective preparation and/or responses to natural disasters by countries with decentralized governments. Clark (2009) applies regression discontinuity to a natural experiment from Britain to show that schools that opt out of the centralized educational regime – in effect decentralizing themselves – enjoy large increases in student achievement. Galiani, Gertler and Schargrodsky (2008) find that decentralization of school control from central to provincial governments in Argentina had a positive impact on student test scores. The poorest, however, did not gain, and indeed may have lost. Barankay and Lockwood (2007) find that greater decentralization of education to Swiss cantons is associated with higher educational attainment, especially for boys. And Faguet and Sánchez (2013) find that decentralization improved enrollment rates in public schools and access of the poor to public health services in Colombia. In both sectors, small increases in own-shares of spending led to surprisingly large increases in the access of the poor. The evidence implies that decentralization provided local officials with the information and incentives required to allocate resources responsively according to voters' needs, and improve the impact of public expenditures. This study hopes to add empirical evidence from a low income country with large,

important decentralization and public investment programs, where results are potentially significant.

Ethiopia is a particularly good context in which to study the decentralized provision of primary services for three reasons: (1) The country's size and recent development experience give it a natural importance in the development community; (2) Its geographic and socio-cultural diversity are amongst the highest in the world, providing natural sources of variation that a study such as this can exploit analytically; and (3) Local services are supported by the Promotion of Basic Services program, the biggest donor-financed program in the world.

Ethiopia has achieved impressive development results in recent years. That progress includes rapid and significant improvements in basic service delivery indicators. An Overseas Development Institute study (2010) noted that Ethiopia is making the third-fastest improvements of any country towards reaching the Millennium Development Goals (MDGs). The latest Ethiopia Demographic and Health Survey data show that child mortality has fallen from 123 per thousand in 2005 to 88 in 2010, and primary net enrollment rates rose from 68 percent in 2004/2005 to 82 percent in 2009/2010. Such progress on basic service delivery is coupled with an impressive growth record over the past decade. GDP grew on average 11 percent per year during 2004/5-2009/10, according to official estimates. Initially led by agriculture, growth has become more broad-based, with a rising contribution from the mining, services and manufacturing sectors. While growth has slowed recently, it still remains among the highest in the world. Based on official data, the population below the national absolute poverty line fell from 38.7 percent in 2004/2005 to 29.6 percent in 2011. Ethiopia achieved the MDG-4 (Child

Mortality) target earlier this year, ahead of schedule, and appears to be on track to reach the other MDGs by 2015[6].

Ethiopia is also home to a great diversity of ecological zones and ethnic and linguistic groups. Its vast system of mountains and highland plateaus is bisected by the Great Rift Valley, itself surrounded by lowland steppes and semi-deserts. In the east are remote deserts containing some of the hottest human settlements on earth, while to the south there are tropical forests. With 93 officially recognized mother tongues and 98 ethnicities by the Ethiopian census, the country is also one of the most ethno-culturally diverse societies on earth. Detailed information on such environmental and social characteristics disaggregated to woreda level makes Ethiopia a rich context for the study of a broad range of development issues.

Decentralization is henceforth defined as the devolution by central government of authority over specific functions, together with the administrative, political and economic attributes that these entail (e.g., tax-raising, expenditure, and decision-making powers), to democratic regional and local governments that are independent of the center within a legally delimited geographic and functional domain. The rest of this paper is organized as follows. Section two discusses the Ethiopian decentralization program within the broader historical context of its long imperial, centralizing tradition, and provides descriptive statistics for public investment flows to education, health and agricultural services. Section three discusses the dataset and presents our methodology. Section four examines decentralization's effects on services and outcomes in the same three sectors, as well as their distribution, with econometric evidence. Section five concludes.

6 UNICEF 2013 Committing to Child Survival: A Promise Renewed. Progress Report 2013 , New York, UNICEF.

2. Centralization and decentralization in Ethiopia

2.1 History and background

The ethnic composition of Ethiopia is the result of a turbulent history. As it consolidated itself during the medieval period, the country was comprised primarily of the Tigray, Agaw and Amhara peoples. With Menelik II's ascension to the throne in 1889, a period of territorial expansion began, whose base was the province of Shoa in the current region of Amhara. Areas consisting of today's Beneshangul-Gemuz, Gambella, Southern Nations and Nationalities, Afar, Oromia and Somali regions were brought under the feudal system of the Ethiopian empire. Following the battle of Adwa in 1896 and the resulting European recognition of Ethiopian statehood, a series of border treaties with the surrounding colonial powers were signed. The modern Ethiopian state was born.

Relations between the newly integrated areas and the historic center of the empire were troubled. Menelik sent governors from the center to administer the periphery, but owing to the structural weakness of the center, successive Ethiopian governments did not command effective control over the peripheries. Similarly, exploitative economic policies caused visible marginalization, relative under-development, and less integration among the border regions within Ethiopia.[7] This hold of the center over the peripheries continued to increase. According to noted Ethiopian historian Bahru Zewde:

> The period after 1941 witnessed the apogee of absolutism. The tentative beginnings in this direction of the pre-1935 years matured into untrammeled autocracy. The power of the state reached a limit unprecedented in Ethiopian history.[8]

---

[7] Mulugeta, Allehone, Issues of Security and Conflict, in the Ethiopian Frontiers: Notes on State Policies and Strategies, in Report of Ethiopia National Workshop - Conflict in the Horn: Prevention and Resolution, (OSSREA Publications), (2002).

[8] Zewde, Bahru, *A History of Modern Ethiopia 1855-1974*, Addis Ababa: Addis Ababa University Press, (1991).

The revised constitution of 1955 solidified the absolute powers of the emperor, claiming "His dignity… inviolable and His power… indisputable". It also entrenched Amharic as sole the official language and the Ethiopian Orthodox Church as the national religion.

The period of socialist rule (1974-1991) saw no diminution in the center's hold over the peripheries and no change in the prevailing economic policies of exploitation. Despite the regime's appeal to a socialist ideology, the Derg was identified with an "Amhara suppresser" by the nationalist liberation movements.[9] Any conduct promoting ethnic individualism, and thereby challenging the state's integrity, was outlawed.

The victory of the Ethiopian People's Revolutionary Democratic Front over the Derg in 1991 saw the reversal of over a hundred years of ethnic homogenization. As Chistopher Clapman says:

> The overthrow of the Mengistu government in May 1991 amounted to more than the collapse of a particular regime. It effectively marked the failure of a project, dating back to Menelik's accession in 1889 of creating a 'modern' and centralized Ethiopian state around a Shoan core.[10]

Ethnic federalism now came to the fore in Transitional Charter, which allowed the rights to self-determination of the country's various "nations and nationalities". Like the Charter, a new constitution in 1995 recognized the rights of ethnic self-determination up to succession. It also created a federal government with nine regional states divided along ethno-lingustic lines – Tigray, Afar, Amhara, Oromia, Somali, Beneshangul-Gemuz, South Nations, Nationalities and Peoples, Gambella, and Harari.

---

[9] Weldemariam, Alemayehu F, Greater Ethiopia: Evolution of a Pluralist Politico-Legal System in a Pluralist Polity, Department of Polictial Science, Faculty of Social and Behavioural Sciences, Leiden University, (2011).

[10] Clapham, Christopher, "Ethnicity and the National Question in Ethiopia", in Peter Woodward and Murray Forsyth (eds.) *Conflict and Peace in the Horn of Africa: Federalism and its Alternatives*, (Brookfield: Darmouth publishing co.), (1994).

Economic integration and equitable development become a primary focus of the new government. Meles Zenawi, the president of the Federal Democratic Republic of Ethiopia, declared in 1997 that:

> It is only through fast economic growth that is broadly shared by the population that we can hope for sustainable peace. And, therefore, one of the most important pillars of our program is fast economic growth that is equitable and broadly shared among the population.[11]

The government adopted a policy of affirmative action towards developing regions whereby Beneshangul-Gemuz, Gambella, Afar and Somali would be provided preferential treatment in terms of budget allocation and increased enrollment in higher education. Even now, however, developing regions still remain to be fully integrated into the economy of the Ethiopian state. The legacy of centralization left few residents of today's developing regions involved in running their region's administrative structures.

Until recently there remained little investment in social and physical infrastructure. Slowly, the emergence of local native elite officially in charge of the regions, better investment in education, health, infrastructure and others have shown the positive outcomes of the federalization of Ethiopia.[12] The preferential treatment of previously disadvantaged ethnic groups within Ethiopia is helping to create a more equitable distribution for development to take place.

Decentralization of political, administrative and fiscal authority to regional and local governments has been fundamental to this affirmative action strategy. The Government has a strong commitment to decentralization and building a federal state, as enshrined in the 1995 Federal Constitution. While the first wave of decentralization started only 20 years ago, the

---

[11] Meles Zenawi, "Premier's speech at Butare National University in Rwanda", in The Ethiopian Herald, (December 13, 1997).

[12] Adegehe, Asnake, Federalism and ethnic conflict in Ethiopia : a comparative study of the Somali and Benishangul-Gumuz regions, (2009).

process should be seen as a work in progress for which the underpinning institutional arrangements for success are evolving and continue to require focused support.

2.2 The Ethiopian decentralization program

To date, Ethiopia has seen two rounds of decentralization. The first round (devolution) took place during the transitional period from 1991 to 1994. This Proclamation devolved state powers to geographically-defined ethno-linguistic groups and associated pieces of legislation were also passed creating regional and woreda (district) councils. As necessary, regions could decide to establish zones as intermediaries between regional and district administrations. In addition to giving them the right to self-determination, these new regional units were granted a range of executive, legislative, and judicial powers within their defined regions, and exercised jurisdiction over matters of social and economic development as well as basic service delivery. Accordingly, regions were to create the necessary internal institutional arrangements, including: a council; an executive committee; a judicial administration office; a public prosecution office; an audit office; a police and security office; and a service and development committee.

Proclamation No. 7/1992 stipulated the regional governing units' revenue sources; these included: tax revenues derived within their jurisdictions; fiscal transfers from the central government; domestic borrowing; and other sources of income. The latter category was specified in Proclamation No. 33/1992. However, due to capacity constraints, the regional governments were yet unable to carry out their revenue assignments; as such, they were highly-dependent on grants from the central government to meet their new expenditure obligations in the social sectors.

In spite of what appears to be a rather elaborate set of governing arrangements, these new regional governments remained subordinate to the central government. While the regional

councils were accountable to citizens living within their regional borders, legally they were also responsible to Council of Representatives of the central government.

The promulgation of the 1995 Federal Constitution signified the beginning of Ethiopia's second round of decentralization. The Constitution affirmed the roles and functions of federal vs. regional government. While the federal government retained authority over a broad range of functions and responsibilities (e.g., fiscal and monetary policy, international trade), the regions and woredas were given responsibility for ensuring basic service delivery in their respective jurisdictions. The federal government retained authority over setting policies and standards in each of the major social service delivery sectors.

In 2002, decentralization was extended to the woreda level with woreda governments expected to take on the bulk of service delivery responsibilities. Woredas receive block grants from their respective regional governments which, like the federal-regional grants, are also governed by formulas set by the regional governments and use broadly similar methodologies to those used in federal-regional grants.

2.3 Descriptive statistics

The resource implications of this second round of decentralization were significant. Table 1 shows the evolution of federal block grants (FBGs) to regions over time. Regions further devolve a large portion of these grants to woredas, although detailed data on this is not yet available.[13] We see that FBGs rose from 13% of total federal expenditures in 1999/00 to 40% in 2012/13, even as total federal expenditure more than tripled. The result is a huge increase in funds available to regions in excess of 300%. Interestingly, FBGs fell as a proportion of total regional expenditures from a peak of 88% to just over half, as new central transfers came on

[13] Data on woreda-level transfers and expenditures are currently only available for 2008-2011, and so omitted here. The next version of this paper should fully incorporate woreda-level data from 2001-2012.

stream and subnational governments developed their own tax bases, implying even more resources for regions and woredas.

Table 1: Federal block grants (FBGs) to regions

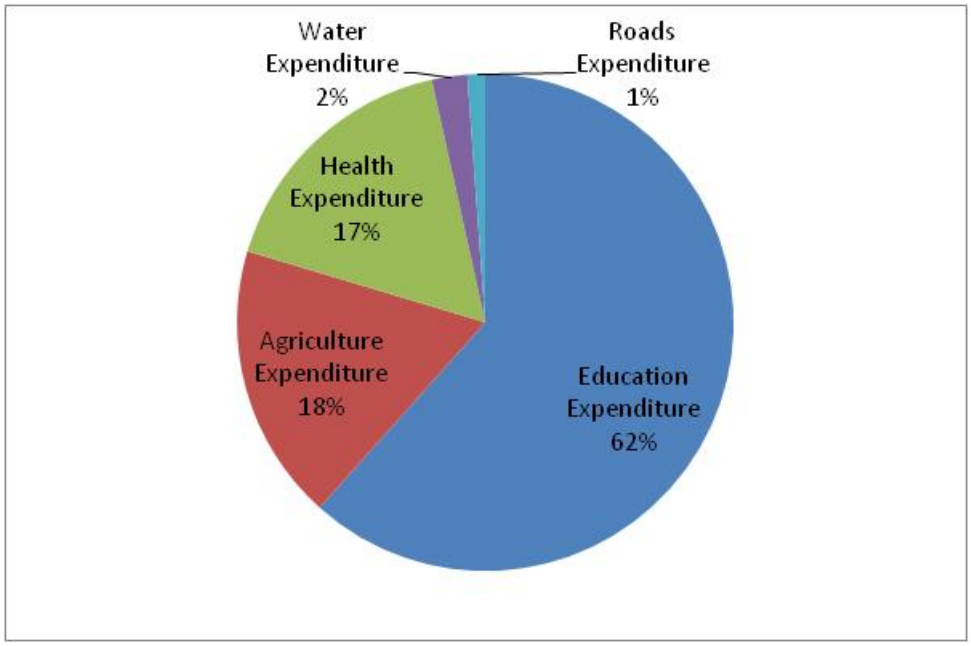
Year (Ethiopian calendar)	Federal block grant to regions (USD millions)	Total federal government expenditures (USD millions)	FBG as % of federal expenditures	FBG as % of total regional expenditures
1993/94		1,408		
1994/95		1,513		
1995/96		1,498		
1996/97	445	1,605	28%	75%
1997/98	444	1,645	27%	78%
1998/99	414	2,029	20%	77%
1999/00	299	2,259	13%	65%
2000/01	426	2,221	19%	77%
2001/02	450	2,129	21%	77%
2002/03	527	2,147	25%	75%
2003/04	583	2,614	22%	79%
2004/05	635	2,616	24%	79%
2005/06	815	2,518	32%	79%
2006/07	1,065	3,067	35%	88%
2007/08	1,464	3,756	39%	85%
2008/09	1,589	3,940	40%	86%
2009/10	1,517	4,116	37%	80%
2010/11	1,587	4,207	38%	81%
2011/12	1,721	4,689	37%	61%
2012/13	1,954	4,895	40%	54%

Sources: Ministry of Finance & Economic Development, National Bank of Ethiopia
N.B. Years are according to the Gregorian (i.e. Western), and not Ethiopian, calendar.

How have subnational governments spent these increasing flows? Figure 1 shows the sectoral breakdown for a typical year, in this case 2011. Education takes the largest share at 62%, followed by agriculture and health in a distant near-tie for second place, at 18% and 17% respectively. Together these three sectors account for 97% of total expenditure, with expenditure on water & sanitation and roads summing to only 3%. This broadly accords with the pattern of

expenditure across developing countries, which typically prioritize education and health above other sectors.

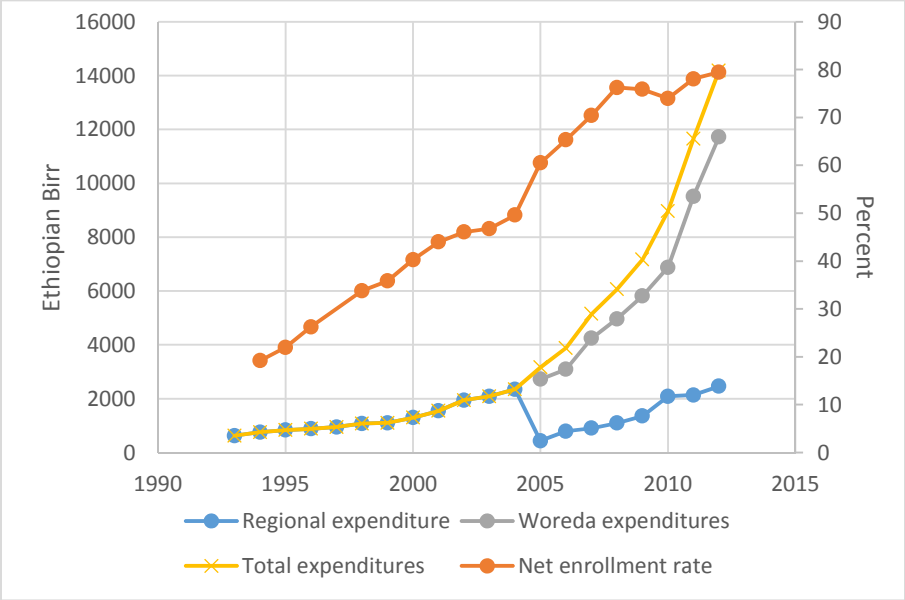
Figure 1: Woreda-level expenditures by sector, 2011



Source: Ministry of Finance & Economic Development

Have such expenditures affected education and health outcomes of interest? Are they having an effect on Ethiopia's development more broadly? Figure 2 shows the evolution of education expenditures at the regional and woreda levels (left axis), plotted against the net enrollment rate (right axis) between 1993-2012. We see a notable rise in education expenditure throughout this period, with a clear acceleration after about 2005, when regional governments begin devolving significant sums to woredas. This is associated with a steady, four-fold rise in the net enrollment rate from under 20% to over 80%, again with an upward surge in 2005.

Figure 2: Growth in subnational education expenditures & net enrollment rate, 1993-2012

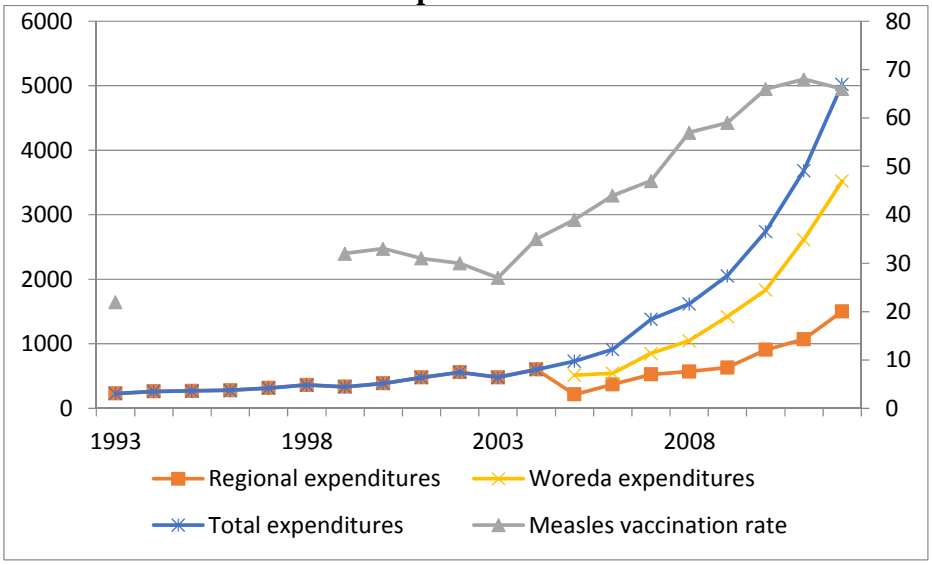


Source: Ministry of Finance & Economic Development

Figures 3-6 plot the same expenditure data against changes in the rates of vaccination against measles and DPT, the rate of detection of TB, and the fertility rate. The data for these variables are being cleaned and corroborated, and still contain gaps and erratic features that we are working to fix. But even so the overall patterns are striking. In figure 3 we see the measles vaccination rate, previously stagnant around 30%, begin a secular rise in 2003 from 27% to 68% by 2011. This coincides with Ethiopia's second round of decentralization to woredas. The DPT vaccination rate (figure 4) similarly begins rising in 2002, from 28% to 65% in 2010. The rate of detection of TB (figure 5) shows an even longer and more dramatic rise, from 11% in 1995 to 68% in 2011. And Ethiopia's fertility rate – a variable that, across countries and cultures, moves slowly in response to broad demographic and economic factors – declines markedly from 7.1 live births per woman in 193 to 4.8 in 2011 (figure 6). In all of these cases, greater decentralization of health expenditure appears be to associated with improving indicators of

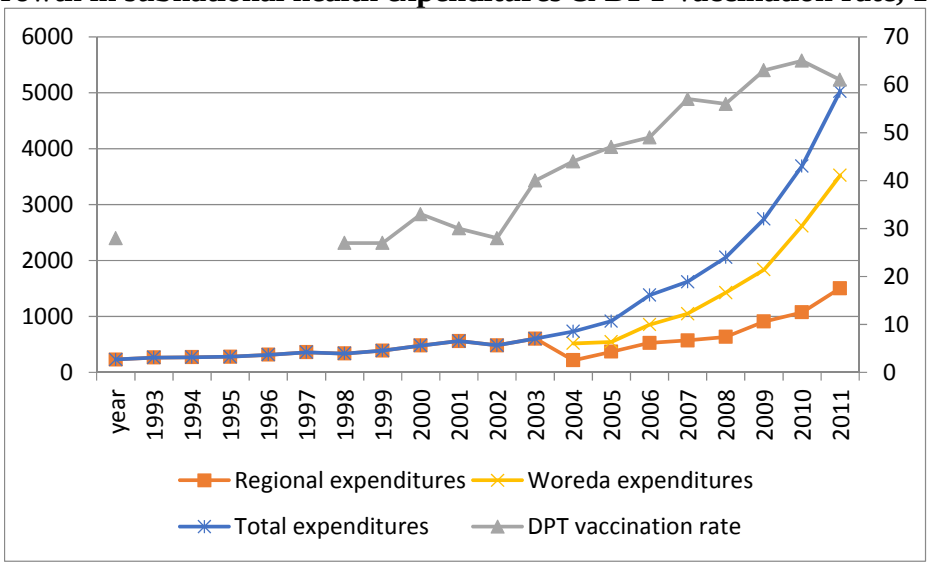
health system outputs, such as vaccination rates, as well as substantive outcomes, such as fertility.

Figure 3: Growth in subnational health expenditures & measles vaccination rate, 1993-2012



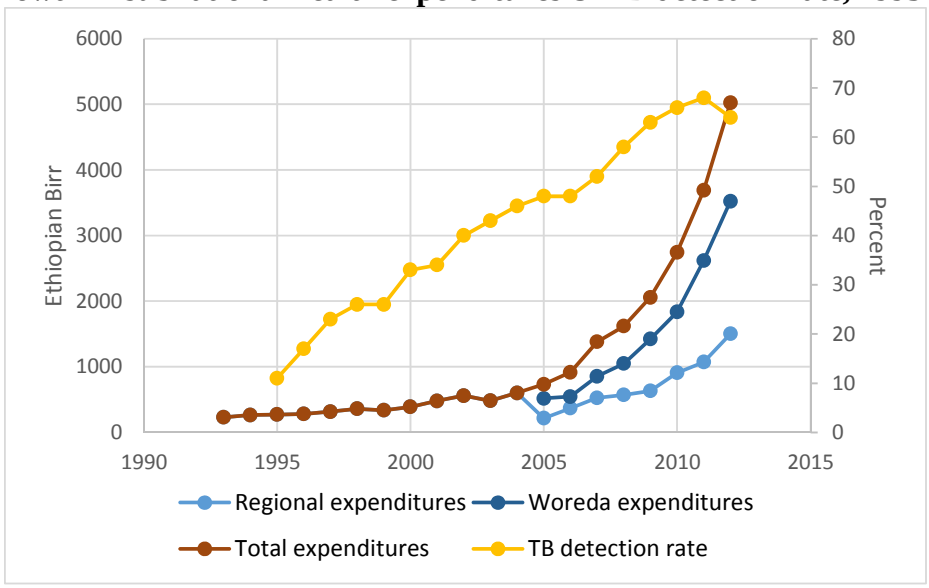
Source: Ministry of Finance & Economic Development

Figure 4: Growth in subnational health expenditures & DPT vaccination rate, 1993-2012



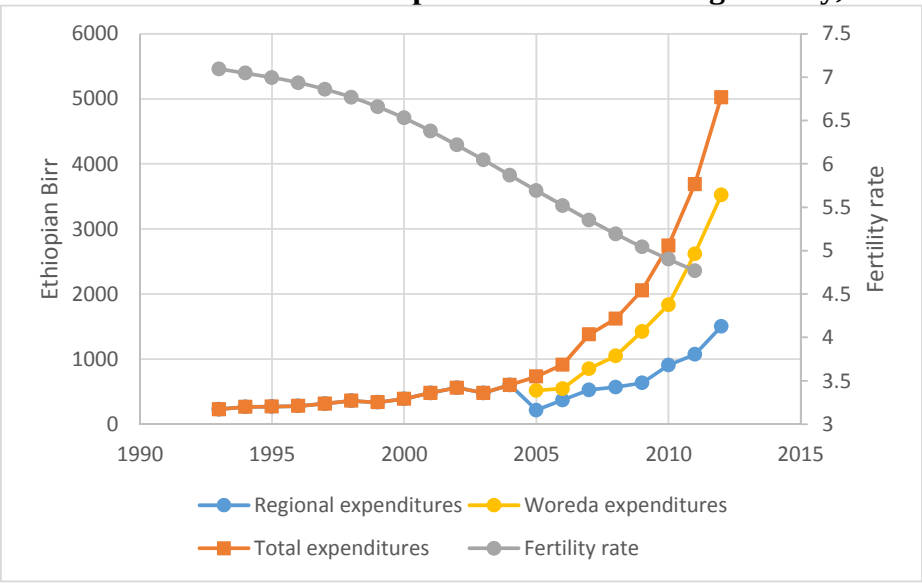
Source: Ministry of Finance & Economic Development

Figure 5: Growth in subnational health expenditures & TB detection rate, 1993-2012



Source: Ministry of Finance & Economic Development

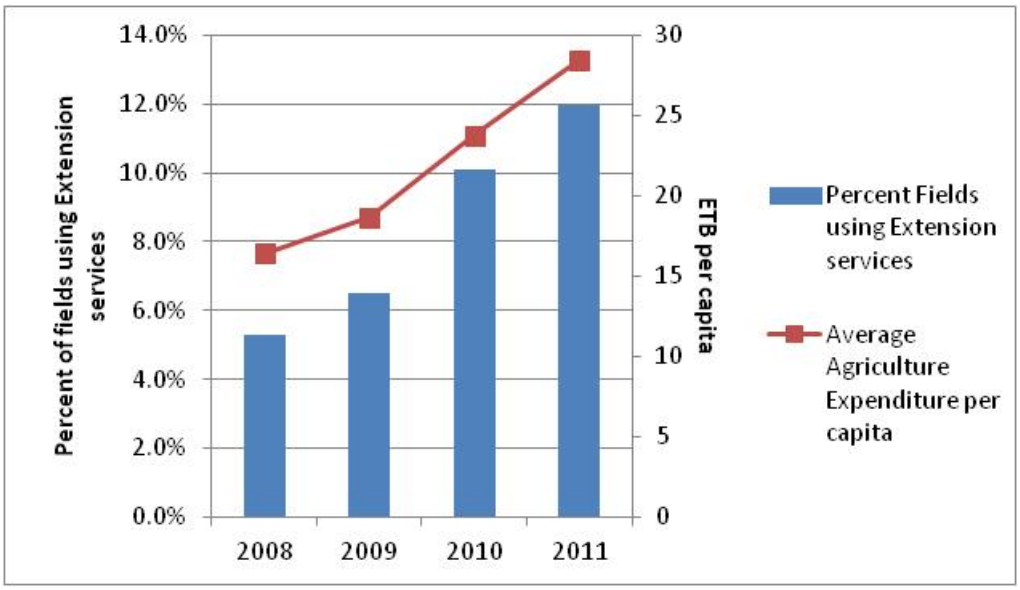
Figure 6: Growth in subnational health expenditures & declining fertility, 1993-2012



Source: Ministry of Finance & Economic Development

Unfortunately, the data for agriculture is in a worse state than other sectors, and so figure 7 only plots the 2008-2011 period. Just as in health and education, agricultural expenditures increased rapidly over this period. Concomitant with this increase, the percentage of fields that use extension services more than doubled. This occurs entirely within the second phase of Ethiopian decentralization, to woredas.

Figure 7: Growth in subnational agriculture expenditures & extension services, 2008-2011



Source: Ministry of Finance & Economic Development

What do these descriptive statistics tell us? Firm conclusions must await the more rigorous evidence presented below. The preceding figures are no more than suggestive. But what they suggest is that rapidly rising decentralized expenditures in education, health and agriculture have led to significant increases in public sector outputs, such as education enrollments and vaccinations against communicable diseases, as well as substantive outcomes such as fertility. And for some of these indicators, improvements accelerate from the early-2000s onwards, with Ethiopia's second round of decentralization to woredas. Are these changes due to decentralization itself, or to the increase in expenditures that coincided with decentralization? We cannot distinguish between these possibilities from the descriptive statistics above, but our more detailed, analytical results below can.

3. Data and Methodology

3.1 Data

One reason an analysis of this sort has not been undertaken until now is the absence of woreda-level data on local economic, demographic, fiscal and other characteristics. Indeed, it is difficult to overstate the difficulty of doing subnational empirical work on Ethiopia. When we began this project, relatively little subnational data was collected, the data was often of poor quality, and few attempts were made to systematize the results into any obviously comparable framework. A few illustrations are telling. Fiscal data on subnational expenditures in health, education, agriculture, water, and roads were until very recently available only for EFY 2003. Their geographic identifying codes and names did not match those of census data, whose geographic codes and names vary in unpredictable but pervasive ways from fiscal data. The last census counted some 740 woredas, zones, and regions, but the fiscal dataset included more than 850. Consolidating these two yielded a dataset of 989 subnational units, 250 more than in the census. Many woredas were listed under the same name, and geographic codes in both data sets were not unique. Missing data abounded.

The database that the team has constructed includes woreda-level data from five ministries – Health, Education, Agriculture, Water and Energy, and Finance and Economic Development – as well as the Central Statistical Agency (CSA), the Disaster Risk Management and Food Security Sector of the Ministry of Agriculture. As standardization of woreda codes and the transliteration of Amharic names into Latin script is not yet consistent between ministries in Ethiopia, much time was dedicated to matching woredas from various sources into a single format. For consistency, the team used the Population and Housing Census of Ethiopia (2007) codes as its base.

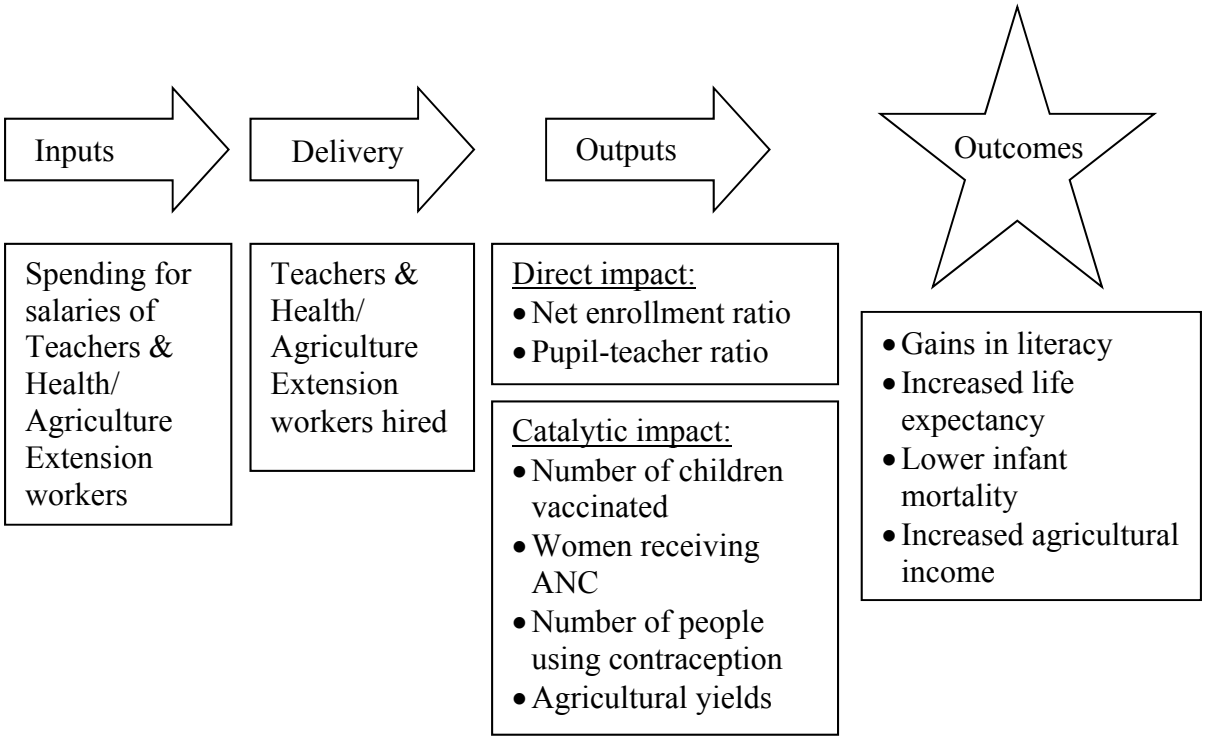
The database includes year-on-year expenditures by sector, and key results by sector, and information on ethnicity, poverty, rainfall, frequency of droughts, and a number of other control

variables. Regional data on per capita capital expenditures and zonal data on crop yields have also been included. Moving forward, we intend to update the database yearly, with yearly results from each sector incorporated as they become available. Building the database required for this report has required a huge amount of work and improvisation on the part of the team undertaking the empirical analysis. It is our hope that this dataset will in time become a useful tool for researchers and students elsewhere in Africa and beyond.

3.2 Methodology

Our primary objective is to assess the effect of woreda-level expenditures for decentralized sectors on key sector outputs and *outcomes*. Ethiopian fiscal rules create a strong association between woreda-level spending in agriculture, education, and health, and key service outputs such as the numbers of agriculture extension workers, teachers, and health extension workers. The causal chain between our right hand side variables ("inputs") and our left hand side variables ("outputs" or "outcomes", depending on data availability) is depicted in figure 8 below. It is useful to keep these relationships in mind when interpreting the econometric results that follow.

Figure 8: Conceptual model of causality for woreda expenditure



Our intention is to use panel regressions to investigate the effects of decentralization on outputs and outcomes in education, health and agriculture. But the current lack of woreda level data from the pre-decentralization period restricts us to simple time-series estimations with nationally aggregated data over the past 20 years, which includes both pre and post-decentralization data. We then corroborate these results with woreda-level data from 2008-2011 inclusive, all of which is in the post-decentralization period. Here we estimate cross-time pooled regressions in order to evaluate the impact of per capita sector expenditure, controlling for rural/urban percentage and ethnicity, on various output and outcome variables of interest. For agriculture, where reliable local outcome data are unavailable, we revert to zonal level data on outcomes. By taking the average per capita woreda spending on agriculture as a proxy for services offered by agriculture extension workers, zonal outcome data can be used to assess spending effectiveness. Data constraints prevent us from analyzing water supply and roads. But

the latter two sectors account for only 3% of total woreda-level spending, implying that our sectoral focus is appropriate. Additionally, national household surveys such as the Demographic and Health Survey (DHS) and the Agriculture Sample Survey are used to complement our analysis from the woreda-level database. Results using household data confirm those from our woreda database, which relies on administrative data.

The analysis consists of three key stages. Stage I is a simple time-series OLS estimation as follows:

$$O_t = \alpha + \beta_1 E_t + \beta_2 D_t + \beta_3 T_t + \beta_4 E_t * D_t + \varepsilon_t \quad (1)$$

Where O captures key education and health outcomes, expressed as rates; E is expenditures in each sector; D is a dummy variable that equals 0 before Ethiopia decentralized to woredas and 1 after; and T is a simple trend variable, all subscripted by year t. We expect sectoral expenditures to positively affect sectoral outcomes, and hence to be statistically significant with the correct sign. If decentralization affects outcomes generally, through administrative, political, or other channels, then we expect the dummy variable to be significant and larger in effect. But if decentralization's main channel of influence is via local discretion over resource allocation, as opposed to more general effects, then we expect the interaction term to take over significance when it is added to the model.

Stage II follows the approach of Faguet (2012) and Faguet and Sánchez (2013), examining the relationship between woreda-level spending in each sector on results in those sectors. We estimate

$$\ln O_{mt} = \alpha + \zeta \ln E_{mt} + \beta R_m + \delta \mathbf{C}_m + \eta \ln K_{mt} + \tau_t + \varepsilon_{mt} \quad (2)$$

where lnO captures key outcomes in each sector through variables such as the net enrollment rate or antenatal care usage. E is yearly expenditure per capita in the relevant sector; K is capital

expenditure per capita; R is the percentage of rural population in each woreda; τ is a year variable to control for the time series effect in this cross time pooled data set; and **C** is a vector of demographic controls, including population percentages of certain historically disadvantaged ethnicities that we focuses on, indexed by woreda m and year t. R and C are census variables, and thus treated as time-invariant.

Log transformations are very commonly used in order to reduce the effect of extreme values on results. But interpreting the coefficients of log-transformed data is not straightforward. Log transformations are often useful for data that exhibit right (positive) skewness, and where the variability of residuals increases for larger values of the dependent variable. When a variable is log transformed, note that simply taking the anti-log of your parameters will not properly back transform into the original metric used.[14]

We also estimate a linear version of (2), as follows:

$$O_{mt} = \alpha + \zeta E_{mt} + \beta R_m + \delta \mathbf{C}_m + \eta K_{mt} + \tau_t + \varepsilon_{mt} . \quad (3)$$

We further add a quadratic term for expenditure to (3), in order to check for decreasing marginal returns, as follows:

$$O_{mt} = \alpha + \zeta E_{mt} + \lambda E_{mt}^2 + \beta R_m + \delta C_m + \eta K_{mt} + \tau_t + \varepsilon_{mt} \quad (4)$$

For all the above equations, it is expected $\delta O/\delta E \geq 0$ and $\delta O/\delta K \geq 0$. Similarly $\delta \ln O/\delta \ln E \geq 0$ (that the first partial derivatives) while in Equation (3) $\delta^2 O/\delta^2 E \leq 0$ (the second partial derivate). The expected results imply a positive association between the dependent variable and the independent variable, per capita woreda expenditures in each sector.

[14] For a clear, concise treatment of this topic, see Jing Yang *Interpreting Coefficients in Regression with Log-Transformed Variables, StatNews #83,* June 2012, Cornell Statistical Consulting Unit, Cornell University, Ithaca, NY. Available at: http://www.cscu.cornell.edu.

Finally, stage III compensates for a lack of woreda-level data on agriculture by using household-level DHS data to estimate a Probit limited dependent variable model, using the following specification:

$$P_{i,q} = \alpha + \rho\zeta \ln E_{mt} + \delta \mathbf{V}_m + \varepsilon_{mt} \quad (5)$$

where $P_{i,q}$ is whether household "i" in quintile "q" adopts improved techniques, measured as "1" for "yes" and "0" for "no". $E_{m,t}$ is per capita expenditure on agricultural extension workers, and $V_{m,t}$ is a vector of control variables, including rainfall.

4. Results

We eventually intend use panel regressions to investigate the effects of decentralization on outputs and outcomes in education, health and agriculture. But the current lack of woreda level data from the pre-decentralization period restricts us to simple time-series estimations with nationally aggregated data over the past 20 years, and full panel estimations using woreda-level data from 2008-2011 inclusive. Realizing this approach is distinctly second-best, we verify these findings with household data from DHS 2005 and 2011 surveys, where we use limited dependent variable (primarily probit) regressions to investigate health and education outcomes. These results corroborate ourmain findings, but are not presented here for lack of space. We hope that this combination of results can tell us something of interest about the effects of decentralization on public service provision in Ethiopia. But we do not pretend that our results are ideal, nor a direct test of the questions we want answered. With luck, better estimations will be possible soon.

National results#

What do national regression results reveal about the links between decentralization and improvements in Ethiopia's public services? Table 2 contains results from our national database

for education. The regression in the first column shows that education expenditure increases the net enrollment rate, but decentralization to woredas has an independent, statistically significant effect. Adding a trend variable removes significance from these first two terms. But when we interact education expenditures with the woreda decentralization dummy (column 3), all four terms are significant. Our interpretation of these results is that it is decentralized expenditures that are driving improvements in Ethiopia's enrollment rates, as distinct from education expenditures more generally, or some other – perhaps political or administrative – aspect of decentralization.

Table 2: Decentralization's effect on education outputs

Education

	Net Enrollment Rate (NER)		
	1	2	3
Education expenditure	0.00254 ***	-0.00046	-0.01329 *
	(0.0007)	(0.0005)	(0.0064)
Woreda decentralization dummy	20.76349 ***	-0.22921	-22.52787 *
	(5.2258)	(3.3025)	(11.4241)
Trend		3.93361 ***	5.41707 ***
		(0.4641)	(0.8453)
Education expenditure x decentralization dummy			0.01178 *
			(0.0058)
constant	30.42987 ***	9.88411 ***	15.93700 ***
	(2.9859)	(2.7265)	(3.8791)
R-squared	0.8610	0.9773	0.9828
Prob > F	0.0000	0.0000	0.0000
N	18	18	18

OLS estimations; standard errors in parentheses
*,**,*** = coefficients significant at the 10%, 5% and 1% levels

Table 3 shows results for health. In column 1 we see that health expenditures appear to drive improvements in DPT vaccinations, but the decentralization dummy is insignificant. Adding a trend variable does not alter this result, and the trend variable is also insignificant. When we add an interaction term for health expenditures and woreda decentralization, by contrast, only this last term approaches significance, and the other three are not. This implies

weakly that decentralized expenditure might improve the DPT vaccination rate, as distinct from health expenditure more generally, or other aspects of decentralization. But the evidence is at best suggestive. Columns 4-6 provide similar results for the measles vaccination rate. Once again, health expenditure is significant in the first model but the decentralization dummy is not, and de-trending the data does not change this (columns 4-5). When we add the interaction term (column 6), however, the results mirror those for education. Decentralized expenditure appears as the strong driver of improvements in Ethiopia's measles vaccinations, as distinct from health expenditures more generally, or other aspects of decentralization.

Table 3: Decentralization's effect on health outputs

Health

	DPT Vaccination Rate			Measles Vaccination Rate		
	1	2	3	4	5	6
Health expenditure	0.00591 **	0.00936 **	-0.10810	0.00812 ***	0.00907 **	-0.13535 **
	(-0.0025)	(0.0035)	(0.0715)	(0.0022)	(0.0032)	(0.0613)
Woreda decentralization dummy	1.07761	12.70117	-49.31069	-0.69042	2.53872	-73.70757 **
	(6.4351)	(10.3539)	(38.9754)	(5.6393)	(9.5665)	(33.4155)
Trend		-1.70519	1.58259		-0.47372	3.56875 *
		(1.2102)	(2.3068)		(1.1182)	(1.9778)
Education expenditure x decentralization dummy			0.11135			0.13691 **
			(0.0677)			(0.0580)
constant	38.54104 ***	46.72068 ***	69.52584 ***	35.87509 ***	38.14747 ***	66.18742 ***
	(3.6858)	(6.8225)	(15.3104)	(3.2300)	(6.3036)	(13.1264)
R-squared	0.3639	0.4341	0.5206	0.5519	0.5569	0.6767
Prob > F	0.0214	0.0247	0.0198	0.0011	0.0039	0.0013
N	20	20	20	20	20	20

OLS estimations; standard errors in parentheses
*,**,*** = coefficients significant at the 10%, 5% and 1% levels

Fertility is a different sort of health indicator. As opposed to vaccination rates, which are direct outputs of government policy and can be directly influenced by government decisions, fertility is a substantive outcome of interest in any population. But fertility decisions are in the gift of mating couples, and only indirectly affected by policy. As a demographic variable, fertility commonly changes much more slowly year by year, across countries, cultures, and

regions of the world. This makes this a more ambitious test of the effects of decentralization. Hence we are wary of finding any effect of decentralization on fertility, which – even if significant – we would expect to be small.

What does the evidence show? Table 4 provides the results of our estimations. As for our education results, both the health expenditure and decentralization dummy variables are associated with decreasing fertility (column 1). The trend variable is also significant (column 2), but unlike all of the other education and health models, adding this does not reduce the significance of the other two variables. But when we add the interaction term (column 3), only the trend variable remains significant. We interpret this as weak evidence that health expenditure and decentralization broadly construed contributed to falling fertility levels in Ethiopia.

Table 4: Decentralization's effect on health outcomes

Health

	Fertility Rate		
	1	2	3
Health expenditure	-0.00041 ***	-0.00015 ***	-0.00011
	(0.0001)	(0.0000)	(0.0006)
Woreda decentralization dummy	-0.87300 ***	-0.26937 ***	-0.24898
	(0.1348)	(0.0665)	(0.2946)
Trend		-0.09698 ***	-0.09814 ***
		(0.0081)	(0.0182)
Education expenditure x decentralization dummy			-0.00004
			(0.0005)
constant	6.88965 ***	7.33326 ***	7.32593 ***
	(0.0743)	(0.0442)	(0.1126)
R-squared	0.9304	0.9933	0.9933
Prob > F	0.0000	0.0000	0.0000
N	19	19	19

OLS estimations; standard errors in parentheses
*,**,*** = coefficients significant at the 10%, 5% and 1% levels

Stepping back from the detail, these results are broadly what the theory of decentralization would predict. They imply that decentralization is improving performance of the public education and health sectors, specifically by raising enrollments in Ethiopia's schools and

increasing the rate of vaccination against measles. The main channel for this appears to be local decisions over decentralized expenditures. But we must remember that the data on which these results are based are still incomplete, at a higher level of aggregation then we would like, and probably still contain errors. Further work with more, and more detailed, data is required.

Post-Decentralization Woreda Expenditures: Education

A large share of local government resources are used to hire primary school teachers. According to the Demographic and Health Survey, between 2005 and 2011 the primary net enrollment rate increased from 68 percent to 82 percent, and the primary completion rate rose from 34 to 49 percent. (Secondary education expenditure is split between woredas and regions, and so has not yet been included in the analysis.) We focus here on the association between woreda level per capita education expenditures on enrolment rates, and pupil-teacher ratios. We do not consider non-salary recurrent costs in education, which come from other levels of government[15]; but this may not matter since in basic education teacher costs are more than 90% of total recurrent costs. We also consider impact of the capital costs such as school buildings which can drive enrolments. Capital expenditure is based on per capita expenditures at the regional level, since most capital spending is done there. The data is cross time pooled data, and a variable for time was included to isolate the time series effects from other effects. Other control variables were percent rural and ethnicity of the woreda (which is a good proxy for historical lags in development). The results in Table 5 are from the log-linear regressions, which we consider to be best form because they eliminate the effects of extreme values and allow for declining returns to scale. Linear regressions and quadratic regressions were also estimated but not reported here. They are in Annex B.

[15] For example education quality is supported under GEQIP (General Education Quality Improvement Project funded by the Government, World Bank, DFID, USAID and many others.

Table 5: Effect of Log of Per Capita Education Expenditure on Log of Education Outcomes

Independent Variable	Dependent Variable/ Indicator	Coefficient/(SE)	Significance
Log of Expenditure	Log of Net Enrollment Rate	0.2705 (.0281)	***
	Log of Pupil-Teacher Ratio	-0.2242 (.0203)	***
Notes: Based on Cross-time pooled dataset from 2008-2011. Standard errors given in parenthesis. Significance is defined as: *** at 1% level. Number of Observations: 2583 for NER and 2695 for PTR.			

The study considered two education-related indicators – the Net Enrollment Rate (NER) and Pupil Teacher Ratio (PTR). For both, there is a strong significant relationship with woreda-level per capita recurrent expenditure, when controlling for the effects of rural/urban percentage and ethnicity. Table 5 presents the main coefficients of interest from our regression analysis. For every additional Ethiopia Birr per capita in woreda education spending, NER increases by 0.20%. These results are all significant at the 1% level, as well as robust to changes in specification. Similar results are seen with the PTR.

Post-Decentralization Woreda Expenditures: Health

Table 6: Effect of Log of Per Capita Health Expenditure on Health Outcomes

	Indicator	Coefficient/(SE)	Significance
Log of Expenditure	Log of Penta 3 vaccinations	-0.0611 (0.0271)	**
	Log of Penta 3 vaccinations on expenditure lagged one year	0.1050 (.0370)	***
	Log of Antenatal Care	0.0784 (0.0341)	**
	Log of Contraceptive Acceptance Rate	-0.0250 (0.0404)	NS
	Log of Contraceptive Acceptance on expenditure lagged one year	0.1373 (.0487)	***
	Log of Deliveries by Skilled Birth Attendants	0.2438 (0.0732)	***

Notes: Based on cross-time pooled dataset from 2008-2011. Standard errors given in parenthesis. Significance is defined as: *** at 1% level and ** at 5% level. Number of Observations: 1,664 for Penta 3, 2,277 for ANC, 2,243 for Contraceptive acceptance rate and 2,154 for Deliveries by skilled birth attendants.

Another significant share of local resources is used for health, mainly for hiring frontline community health workers called health extension workers (HEWs). HEWs do not provide extensive curative services. Their main purpose is threefold: to promote behavioral change leading to the adoption of healthy lifestyle practices among members in their community; to act as a referral mechanism for complicated cases, such as difficult pregnancies or severe child malnutrition, to be brought to a Health Center for treatment by trained health professionals; and to provide periodically schedulable services, the most important among them are immunization, family planning (insertion of contraceptive implants) and antenatal care. Regarding maternal health, HEWs are supposed to mobilize women to seek skilled care by “Skilled Birth Attendants”. This title is reserved for nurses, health officers, trained midwives and physicians.

While taking up a smaller percentage of expenditure, these positions are nonetheless funded from the local level budget.

This study considered the association of expenditure on four health-related outcomes – the Penta3 vaccination rate, percentage of pregnant women who received Antenatal Care (ANC), Contraceptive Acceptance Rate (CAR), and percentage of Deliveries by Skilled Birth Attendants (DelSBA). Each is directly related to local-level health expenditure. Table 6 presents the results. As for education, the data is cross time pooled data and variable for time was also included to isolate the time series effects from other effects. Other control variables were per capita capital expenditures (at the regional level) percent rural and ethnicity of the woreda (which is a good proxy for historical lags in development. The results in Table 6 are from the log-linear regressions, which we consider best form because it eliminates the effects of extreme values and allows for declining returns to scale. Linear regressions and quadratic regressions were also estimated, and are reported in the Annex.

The results show that increased health expenditures by woredas improve rates of Penta 3 vaccinations, women receiving antenatal care, contraceptive use, and deliveries by SBAs. All of these results are significant at the 1% level, and all are robust to changes in specification. Again as for education, we only consider per capita woreda level spending which covers health extension workers and health center staff. Non-salary and capital costs are not covered, but clearly can also impact final results. HEWs can convince mothers to immunize their children, but the immunization must also be available; these are financed separately.

All of these indicators are directly related to the responsibilities of HEWs, where the majority of local level recurrent health expenditure is directed. In terms of vaccination rates, HEWs are the frontline workers meant to mobilize the community during immunization

campaigns. They also are the first source for pregnant women to seek ANC services, as well as being the primary spokespeople informing the community of the importance of contraception in family planning. While not technically "skilled birth attendants", their focus on referral of pregnancies to those professionals in health centers impacts the proportion of women who are able to give birth with a trained provider.

A smaller percentage of local health expenditure is directed to the health center level. By federal mandate, each of the 3,000 health centers is supposed to be staffed by one to three health officers, depending on the characteristics of the host community. Each health officer is backed up by a team of about four nurses. There is also at least one trained midwife at each health center. While each of the indicators assessed could be subject to a mixture of influences between HEWs and health center staff, the majority of the effect for all except deliveries by skilled birth attendant would be expected to come from HEWs. Deliveries by SBAs would be influenced more equally by both HEWs and health center staff.

Post-Decentralization Woreda Expenditures: Agriculture

Ethiopia relies heavily on agriculture. It comprises almost half of the country's GDP and employs around 80% of its people. The government and donors support the agriculture sector by financing recurrent costs at woreda level. The majority of these costs are directed towards the employment of development agents (DAs). DAs are trained workers who provide extension services by teaching community members the benefits of improved farming techniques. Such techniques can include the use of improved seeds and fertilizer, and the importance of irrigation and erosion prevention, among others.

Association of Extension Services with Productivity

As in health and education, agricultural expenditure increased rapidly between 2008 and 2011. Concomitant with this increase, the percentage of fields that use extension services has more than doubled. When cross-time pooled regressions are run on agricultural data between 2008 and 2011, there is a significant effect of zonal agriculture expenditure on a variety of improved farming techniques (Table 7). The regressions control for the same aspects as those for health and education – the percentage of the population that is rural, and the ethnic composition of the zone. Here the deviation in rainfall for both the current and previous year from the average rainfall between 1996 and 2011 at zonal level is also included as a predictor. In all regressions where an agricultural variable is included on the left-hand side, both the current year's as well as the previous year's deviation from average rainfall is a significant predictor.

Table 7: Effect of One birr per Capita spending on Agriculture Extension workers on usage of Farmers' Extension Services

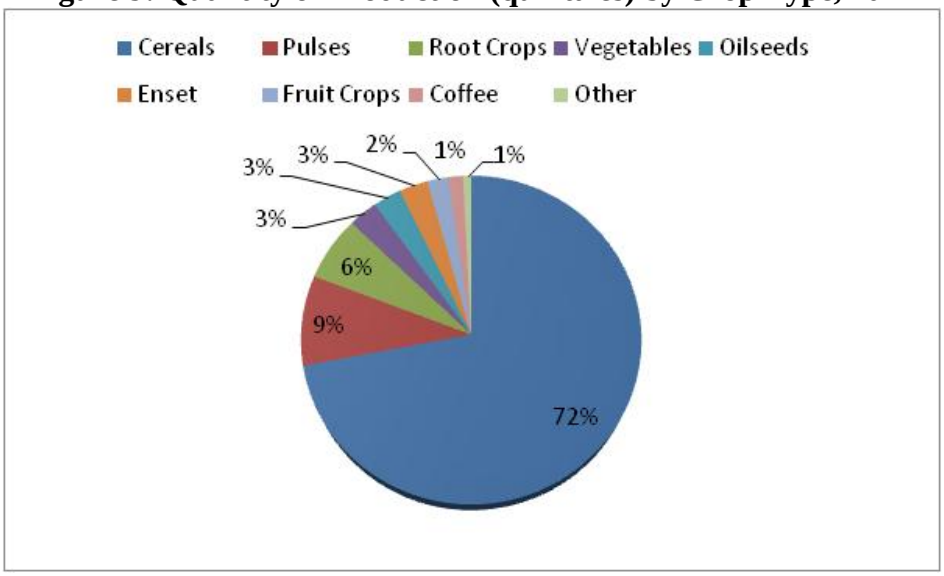
Indicator	Coefficient/(SE)	Significance
Field using Extension Services	0.0008 (0.0004)	**
Field using Improved Seeds	0.0002 (0.0001)	*
Field using Fertilizer	0.0007 (0.0003)	**

Notes: Based on Probit models. Cross-time pooled data drawn from Agricultural Sample Survey data from 2008-2011, pooled at zonal level. Number of observations: 191. Controls include current and previous years' deviations from average rainfall (calculated as the average between 1996 and 2011), zonal poverty rate, percentage of the zone's population that is rural, and the same ethnic groupings as used in the regressions above. Standard errors given in parenthesis. Significance is defined as: ** at 5% level and * at 10% level.

Although the effects appear to be relatively small, the results show that for several aspects of improved farming techniques there are significant and positive associations with zonal per capita agriculture spending. For every additional USD 1 per capita spent, for example, the probability that a field in that zone will benefit from extension services increases by about 0.2% (assuming and exchange rate of ETB20/USD). Specifically, usage of fertilizer and improved

seeds has smaller coefficients but remain positively significant. Irrigation is one technique that is not associated with higher agriculture spending. This could be due to higher capital costs associated with irrigating fields, and would therefore be dependent more on a particular zone's expenditure in the water sector.

Figure 9: Quantity of Production (quintales) by Crop Type, 2011



Notes: Other includes hops and chat. The chart does not include sugar, which is not often grown on private land.

Figure 9 shows the overall basket of crops produced by Ethiopian private farmers in 2011 by production quantity, measured in quintales. Cereals, which include barley, teff, wheat, sorghum, maize, oats, and rice, make up almost three-quarters of production. A further 15% consists of pulses (e.g. beans, chick peas and lentils) and root crops (e.g. potatoes, carrots and onions). Enset, fruit crops and coffee, which are more geographically confined, represent a smaller proportion of overall production.

The overall objective of agriculture spending is to increase the productivity of farmers' fields. Productivity is measured by yield, which is the ratio of quintals produced per hectare of land cultivated. Cross-time pooled regressions between 2008 and 2011, with the log of yield of a specific category of crop as the dependent variable, show strong positive relationships with log

per capita recurrent agricultural spending and crop yields. The control variables were - the percentage of the population that is rural, the zone's overall poverty rate, the deviation of the zone's rainfall for the current and past year from the average, and ethnic composition (this latter variable helps account for geographical heterogeneity in crops' production).

Of the eight groups of crops grown in Ethiopia, five show positive and significant relationships with agricultural spending (table 8). These five represent about 85% of the production in the country. These results, combined with the effect of agriculture spending on extension services given above, imply that local agricultural investment is playing an important role in increasing farmer productivity levels. A caveat here is the role is only catalytic because the actual productivity increase depends on a range of the private and public spending as well as investments in infrastructure, which are not included here.

Table 8: Association of Log of Per Capita spending on Agriculture Extension workers with Yield

Independent Variable	Dependent Variable/Indicator (Yield in Quintales/Hectare)	Coefficient/(SE)	Significance
Log Linear Regression Estimates			
Log of Expenditure	Log of Cereal yield	0.128 (0.0257)	***
	Log of Pulses Yield	0.020 (0.0455)	NS
	Log of Root Crops yield	0.320 (0.1080)	NS
	Log of Vegetables yield	0.583 (0.0674)	***
	Log of Oilseeds yield	-0.118 (0.0851)	NS
	Log of Enset Yield	2.397 (0.2315)	***
	Log of Fruits Yield	1.791 (0.1360)	***
	Log of Coffee Yield	1.267 (0.1302)	***

Notes: Cross-time pooled data drawn from Agricultural Sample Survey data from 2008-2011, pooled at zonal level. Number of observations: 167 for cereals, 159 for pulses, 152 for root crops, 167 for vegetables, 151 for oilseeds, 90 for enset, 162 for fruits and 137 for coffee. Standard errors given in parenthesis. Significance is defined as: *** at 1% level and NS is not significant.

5. Conclusions

National evidence presented here suggests that decentralization is improving the performance of Ethiopia's public education and health services, specifically by raising school enrollments and increasing the rate of vaccination against measles. The main channel for these changes appears to be local decisions over decentralized expenditures. But we must remember that the data on which these results are based are still incomplete, at a higher level of aggregation then we would like, and probably still contain errors. Further work with more, and more detailed, data is required.

Disaggregated, woreda-level data from a shorter period in the post-decentralization period confirm these results in much greater detail. Decentralized expenditures in education, health and agriculture is associated with increases in the net enrollment rate, pupil teacher ratio, Penta 3 vaccinations, percentage of women receiving antenatal care, contraceptive acceptance rate, and the percentage of deliveries by skilled birth attendants. Our estimates imply that an incremental dollar of

local expenditure has significant real effects, on the order of a 3.6% increase in the net enrollment rate, or an 11.3% increase in deliveries by skilled birth attendants.

It is difficult to overstate the difficulty of doing subnational empirical work on Ethiopia. Creating the database required for this report has required a huge amount of work and improvisation on the part of the research team. A major output of this study is the production of a standardized database of woreda-level expenditures and characteristics, which will be made public. The data will be combined with new data coming from ongoing data collection financed by donors, and will also be used to prepare future studies in this line of research. It is our hope that this dataset will in time become a useful tool for researchers and students elsewhere in Africa and beyond.

References

Assefa, Fisshea *Federalism and the Accommodation of Diversity in Ethiopia*, Eclipse Press, Addis Ababa, Third Edition 2010

Barankay, I. and Lockwood, B. 2007. Decentralization and the productive efficiency of government: Evidence from Swiss cantons. *Journal of Public Economics,* 91: 1197–1218.

Batina, R.G. and Ihori, T. 2005. *Public goods: theories and evidence.* New York: Springer.

Besley, T. and Coate, S. 2003. Centralized versus decentralized provision of local public goods: A political economy approach, *Journal of Public Economics*, 87: 2611-37.

Bevan, Phillipa, Catherine Dom and Alula Pankhurst. 2010. *Long-term Perspectives of Development Impacts in Rural Ethiopia: Wide Stage One Final Report*, Mokoro Limited, Oxford.

Boone, P. and J.P. Faguet. 1998. "Multilateral Aid, Politics and Poverty: Past Failures and Future Challenges", chapter 2 in R. Grant and J. Nijman (eds.). *The Global Crisis in Foreign Aid*, Syracuse: Syracuse University Press, 11-26.

Cassette, A. and Paty, S. 2010. Fiscal decentralization and the size of government: A European country empirical analysis. *Public Choice*, 143: 173–189.

Ceballos, M. and Hoyos, D. 2004. Tendencias del comportamiento electoral y descentralización en los municipios de Colombia, 1988-2000. Crisis States Programme Working Paper No. 57, London School of Economics.

Central Statistical Agency of Ethiopia (CSA) *Voice of the Central Statistical Agency*, Various Issues.

Clark, D. (2009) The performance and competitive effects of school autonomy. *Journal of Political Economy*, 117(4): 745-782.

Devarajan, S., Khemani, S. and Shah S. 2009. The politics of partial decentralization. In Ahmad, E. and Brosio, G. (Eds.). *Does decentralization enhance service delivery and poverty reduction?* Cheltenham: Edward Elgar.

Dowding, K. and John, P. 1994. Tiebout: A survey of the empirical literature. *Urban Studies*, 31 (4/5): 767-97.

Dom, Catherine and Stephen Lister with Manos Antoninis. 2010. *An Analysis of Decentralization in Ethiopia*, Mokoro Ltd., Oxford.

Eldon, Jack, Abebe, Cunningham and Bibby. 2011. *Options for Support to Service Delivery in Ethiopia's Developing Regional States,* draft report.

Escaleras, M. and Register, C.A. 2012. Fiscal Decentralization and Natural Hazard Risks. *Public Choice*, 151, 1, 165-183.

Faguet, J.P. 2013. "Decentralization and Governance." *World Development,* 53: 2-13. http://dx.doi.org/10.1016/j.worlddev.2013.01.002

Faguet, J.P. 2012. *Decentralization and Popular Democracy: Governance from Below in Bolivia.* Ann Arbor: University of Michigan Press.

Faguet, J.P. 2004. "*Why So Much Centralization? A Model of Primitive Centripetal Accumulation*." LSE-STICERD Development Economics Discussion Paper No. 43.

Faguet, J.P. 2000. "Decentralization and Local Government Performance: Improving Public Service Provision in Bolivia", *Revista de Economía del Rosario*, 3(1): 127-176.

Faguet, J.P. and Z. Ali. 2009. "Making Reform Work: Institutions, Dispositions and the Improving Health of Bangladesh." *World Development,* 37: 208–218.

Faguet, J.P. and F. Sánchez. 2013. "Decentralization and Access to Social Services in Colombia." *Public Choice*. DOI 10.1007/s11127-013-0077-7.

Faguet, J.P. and F.B. Wietzke. 2006. "Social Funds and Decentralization: Optimal Institutional Design." *Public Administration and Development*, 26(4): 303-315.

Galiani, S., Gertler, P. and Schargrodsky, E. 2008. School decentralization: Helping the good get better, but leaving the poor behind. *Journal of Public Economics*, 92: 2106–2120.

Garcia, Marito and Andrew Sunil Rajkumar. 2008. *Achieving Better Service Delivery in Through Decentralization in Ethiopia*, Working Paper No. 131, World Bank, Washington.

Gonçalves, S. 2013. The effects of participatory budgeting on municipal expenditures and infant mortality in Brazil. *World Development*. http://dx.doi.org/10.1016/j.worlddev.2013.01.009

Granados, C. and F. Sánchez. 2013. Water Reforms, Decentralization and Child Mortality in Colombia, 1990-2005. *World Development*. In Press.

IPE Global. 2010. *Evaluation and Design of Social the Social Accountability Component of the Protection of Basic Services Project*, New Delhi.

Krishan, Pramila and Manasa Patnam, 2013 "Neighbours and Extension Agents in Ethiopia: Who matters more?" in *American Journal of Agriculture Economics* 96(1): 308-327

Manor, J. 1999. *The political economy of democratic decentralization*. Washington, DC: World Bank.

Oates, W. 1972. *Fiscal federalism*. New York: Harcourt Brace.

Ostrom, E. and Whitaker, G.P. 1973. Does local community control of police make a difference? Some preliminary findings. *American Journal of Political Science*, 17: 48-76.

Ostrom, E., Schroeder, L. and Wynne, S. 1993. *Institutional incentives and sustainable development: Infrastructure policies in perspective*. Boulder: Westview Press.

Piriou-Sall, S. 1998. Decentralisation and Rural Development: A Review of Evidence. Manuscript, Washington, DC.

Prohl, S. and Schneider, F. 2009. Does decentralization reduce government size? A quantitative study of the decentralization hypothesis. *Public Finance Review*, 37(6): 639-664.

Prud'homme, R. 1995. On the Dangers of Decentralisation. *World Bank Research Observer,* 10: 210-226.

Putnam, R.D. 1993. *Making Democracy Work: Civic Traditions in Modern Italy* (Princeton: Princeton University Press).

Ragasa, Catherine, Guush Berhane, Fanayae Tadesse and Alemayehu Seyoum Taffesse 2012 *Gender Differences in Access to Extension Services and Agriculture Productivity*, Ethiopia Strategy Support Program (ESSP) Ethiopia Development Research Institute (EDRI) and International Food Policy Research Institute (IFPRI) ESSP Working Paper 49

Rondinelli, D.A., Cheema, G.S. and Nellis, J. 1983. Decentralisation in Developing Countries: A Review of Recent Experience. Staff Working Paper No.581, World Bank, Washington, DC.

Reynolds, Robert C. and Buli Edjeta. 2011. *Strengthening Grievance Redress Mechanisms for the Protection of Basic Services Program in Ethiopia*, Addis Ababa.

Samoff, J. 1990. Decentralisation: The Politics of Interventionism. *Development and Change*, 21: 513-530.

Selam Development Consultants. 2013. *Financial Transparency and Accountability Implementation Assessment Report*, Addis Ababa.

Smoke, P. 2001. Fiscal Decentralisation in Developing Countries: A Review of Current Concepts and Practice. Democracy, Governance and Human Rights Programme Paper No. 2, UNRISD, Geneva.

Solomon, Negussie. 2008. *Fiscal Federalism in the Ethiopian Ethnic-based Federal System*, Forum of Federations, Addis Ababa.

Tassew Woldehanna, Eyasu Tsehaye and Ruth Hill. Forthcoming. *The Distributional Impact of Fiscal Policy in Ethiopia.* Contribution to a Global Study of Fiscal Incidence led by Nora Lustig, World Bank, Washington DC

Tiebout, C. M. 1956. A pure theory of local expenditures. *Journal of Political Economy*, 64:416-24.

Treisman, D. 2007. *The architecture of government: Rethinking political decentralization*. New York: Cambridge University Press.

Vaillancourt, Francois. 2013. *Sharing central revenues with regions: an examination of principles and practices in the context of the PBS (Ethiopia) program*, World Bank, Addis Ababa.

Wang, Huihui. G.N.V. Ramana, Jie Huang and Bekele Chaka (forthcoming) *Ethiopia Universal Health Care Case Study,* World Bank, Washington, DC

World Bank Ethiopia. 2011. *An Assessment of Public Finance Management Systems in Woreda Governments*, Addis Ababa.

World Bank. 2010. *Financial Transparency and Accountability Initiative in Ethiopia: Progress and Way Forward*, Addis Ababa.

Annex 1: Data Summary

Variable	Obs	Mean	Std. Dev.	Min	Max
Outcome					
Net enrollment rate	18	52.43	20.53	19	79
DPT vaccination	20	45.80	13.43	27	65
Measles vaccination	20	44.75	14.02	22	68
Fertility rate	19	6.10	0.79	5	7
Expenditure					
Education expenditures	20	3783.70	3934.14	628	14182
Health expenditures	20	1136.15	1309.77	229	5025
Education expenditure x woreda decentralization dummy	20	3232.85	4339.50	0	14182
Health expenditure x woreda decentralization dummy	20	962.10	1425.15	0	5025
Trend	21	11.00	6.20	1	21
Woreda decentralization dummy	21	0.52	0.51	0	1

Annex 2: Detailed Regression Results from Post-Decentralization Woreda Database

Stage 1: Education

Linear Regression

Dependent variable: Net Enrollment Rate

Independent variables:	OLS
Yearly expenditure per capita in Education	0.045
	(0.0091)
Yearly regional per capita Capital Expenditure	174.331
	(1580.6640)
Percentage of rural population	-12.283*
	(6.7861)
Ethnicity controls	
Nuwer	-7.387
	(24.1886)
Anyiwak	-11.089
	(27.8701)
Gumuz	-16.048
	(24.4713)
Konso	-48.182
	(44.7173)
|Hist. Adv.	-0.967
	(7.2677)
Somalie	-62.222***
	(10.1186)
Affar	77.755***
	(11.4409)
Other Small	-13.178
	(8.5432)
Time controls	
T zero	-3.548***
	(1.2457)
T one	-4.863***
	(.9834)
T two	-0.301
	(0.6894)
T three	Omitted
Constant	104.449***
	(9.4504)

Quadratic Regression

Dependent variable: Net Enrollment Rate

Independent variables:	OLS
Yearly expenditure per capita in Education	0.025
	(0.0223)
Yearly expenditure per capita in Education Squared	-0.00005
	(0.00003)
Yearly regional per capita Capital Expenditure	55.277
	(1583.27)
Percentage of rural population	-10.394

	(6.8810)
Ethnicity controls	
Nuwer	-8.569
	(24.1212)
Anyiwak	-13.453
	(27.8232)
Gumuz	-18.196
	(24.4323)
Konso	-48.041
	(44.5685)
|Hist. Adv.	-1.193
	(7.2454)
Somalie	-61.075***
	(10.1151)
Affar	-77.279***
	(11.4079)
Other Small	-13.489
	(8.5172)
Time controls	
T zero	-2.438*
	(1.4520)
T one	-3.952***
	(1.1585)
T two	0.087
	(0.7375)
T three	Omitted
Constant	100.071***
	(9.8686)
Log Linear Regression	
Dependent variable: Log Net Enrollment Rate	
Independent variables:	OLS
Log yearly expenditure per capita in Education	0.270***
	(0.0280)
Log yearly regional per capita Capital Expenditure	-35.212
	(23.2644)
Percentage of rural population	0.120
	(0.0830)
Ethnicity controls	
Nuwer	-0.168
	(0.2855)
Anyiwak	-0.545*
	(0.3307)
Gumuz	-0.316
	(0.2900)
Konso	-0.452
	(0.5269)
|Hist. Adv.	0.026
	(0.0859)
Somalie	-0.923***
	(0.1215)

Affar	-1.619***
	(0.1357)
Other Small	-0.145
	(0.1007)
Time controls	
T zero	0.098***
	(0.0236)
T one	0.059***
	(0.0185)
T two	0.041
	(0.0111)
T three	Omitted
Constant	3.039***
	(0.1906)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels

Linear Regression
Dependent variable: Pupil-Teacher Ratio

Independent variables:	OLS
Yearly expenditure per capita in Education	-0.024
	(0.0199)
Yearly regional per capita Capital Expenditure	8000.899***
	(2800.951)
Percentage of rural population	15.676
	(4.7215)
Ethnicity controls	
Nuwer	-3.408
	(13.6348)
Anyiwak	-32.619*
	(17.6828)
Gumuz	-21.557
	(14.7049)
Konso	-18.551
	(26.2358)
|Hist. Adv.	-15.588***
	(4.1635)
Somalie	39.245***
	(6.1928)
Affar	-26.338***
	(7.1540)
Other Small	-7.671
	(4.7664)
Time controls	
T zero	6.381**
	(2.6909)
T one	1.990

	(2.1899)
T two	4.038**
	(1.6336)
T three	Omitted
Constant	43.085***
	(8.1009)
Quadratic Regression	
Dependent variable: Pupil-Teacher Ratio	
Independent variables:	OLS
Yearly expenditure per capita in Education	-0.110***
	(0.0403)
Yearly expenditure per capita in Education Squared	0.0002**
	(0.00006)
Yearly regional per capita Capital Expenditure	7472.043***
	(2805.786)
Percentage of rural population	12.328**
	(4.9101)
Ethnicity controls	
Nuwer	-0.908
	(13.6528)
Anyiwak	-34.057**
	(17.6673)
Gumuz	-17.969 (14.7562)
Konso	-18.807 (26.1966)
|Hist. Adv.	-14.821***
	(4.1692)
Somalie	35.936***
	(6.3310)
Affar	-28.423***
	(7.1947)
Other Small	-7.151
	(4.7640)
Time controls	
T zero	3.476
	(2.9395)
T one	-0.288
	(2.3785)
T two	3.067*
	(1.6798)
T three	Omitted
Constant	53.924***
	(9.2286)
Log Linear Regression	
Dependent variable: Pupil-Teacher Ratio	
Independent variables:	OLS
Log yearly expenditure per capita in Education	-0.224***
	(0.0202)
Log yearly regional per capita Capital Expenditure	85.212***
	(19.7773)

Percentage of rural population	0.202***
	(0.0363)
Ethnicity controls	
Nuwer	0.139
	(0.1117)
Anyiwak	-0.718***
	(0.1364)
Gumuz	-0.378
	(0.1189)
Konso	-0.315
	(0.2126)
|Hist. Adv.	-0.238***
	(0.0334)
Somalie	0.122**
	(0.0498)
Affar	-0.618***
	(0.0582)
Other Small	-0.136***
	(0.0386)
Time controls	
T zero	-0.033
	(0.0203)
T one	-0.088***
	(0.0159)
T two	0.000
	(0.0106)
T three	Omitted
Constant	4.914***
	(0.1251)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels

Stage 1: Health

Linear Regression

Dependent variable: Penta3 Vaccination Rate

Independent variables:	OLS
Yearly expenditure per capita in Education	-0.063***
	(0.0233)
Yearly regional per capita Capital Expenditure	-1447.151
	(1315.3060)
Percentage of rural population	8.677***
	(1.8676)
Ethnicity controls	
Nuwer	-64.966***
	(6.4810)
Anyiwak	-53.901***
	(8.3259)
Gumuz	-44.426***
	(7.3255)

Konso	-50.230**
	(24.1339)
|Hist. Adv.	-9.565***
	(2.0970)
Somalie	-51.458***
	(2.7817)
Affar	-47.295***
	(3.2447)
Other Small	-13.755***
	(2.4127)
Time controls	
T zero	-9.362***
	(1.2211)
T one	-3.007**
	(1.2684)
T two	-6.915***
	(0.8858)
T three	Omitted
Constant	91.697***
	(3.1549)
Quadratic Regression	
Dependent variable: Penta3 Vaccination Rate	
Independent variables:	OLS
Yearly expenditure per capita in Education	-0.122***
	(0.0395)
Yearly expenditure per capita in Education Squared	0.0003*
	(0.0001)
Yearly regional per capita Capital Expenditure	-1431.498
	(1315.529)
Percentage of rural population	8.152***
	(1.8899)
Ethnicity controls	
Nuwer	-64.123***
	(6.4999)
Anyiwak	-55.78***
	(8.3911)
Gumuz	-43.354***
	(7.3510)
Konso	-49.085**
	(24.1561)
|Hist. Adv.	-9.581***
	(2.0974)
Somalie	-51.333***
	(2.7833)
Affar	-46.810***
	(3.2567)
Other Small	-13.546***
	(2.4160)
Time controls	
T zero	-9.963***

	(1.2633)
T one	-3.535***
	(1.2994)
T two	-7.166***
	(0.8955)
T three	Omitted
Constant	93.646***
	(3.3278)
Log Linear Regression	
Dependent variable: Penta3 Vaccination Rate	
Independent variables:	OLS
Log yearly expenditure per capita in Education	-0.061**
	(0.0270)
Log yearly regional per capita Capital Expenditure	-43.230 (37.8668)
Percentage of rural population	0.182***
	(0.0512)
Ethnicity controls	
Nuwer	-1.939***
	(0.1816)
Anyiwak	-1.048***
	(0.2274)
Gumuz	-0.701***
	(0.2067)
Konso	-0.592
	(0.6551)
|Hist. Adv.	-0.125**
	(0.0607)
Somalie	-1.048***
	(0.0796)
Affar	-1.076***
	(0.0915)
Other Small	-0.223***
	(0.0694)
Time controls	
T zero	-0.193***
	(0.0416)
T one	-0.104**
	(0.0428)
T two	-0.142 ***
	(0.0296)
T three	Omitted
Constant	4.689***
	(0.1379)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels

Linear Regression

Dependent variable: Antenatal Care

Independent variables:	OLS
Yearly expenditure per capita in Education	0.026
	(0.0313)
Yearly regional per capita Capital Expenditure	-249.548
	(1711.0580)
Percentage of rural population	-10.849***
	(2.4200)
Ethnicity controls	
Nuwer	-56.384***
	(8.5451)
Anyiwak	-44.982***
	(10.2385)
Gumuz	-59.973***
	(9.1047)
Konso	-42.666 (30.2839)
|Hist. Adv.	-13.034***
	(2.5008)
Somalie	-41.722***
	(3.4255)
Affar	-59.354***
	(4.0043)
Other Small	-13.486***
	(2.8967)
Time controls	
T zero	-13.198***
	(1.6319)
T one	-6.886***
	(1.6671)
T two	-4.589***
	(1.2176)
T three	Omitted
Constant	96.300***
	(4.0269)

Quadratic Regression

Dependent variable: Antenatal Care

Independent variables:	OLS
Yearly expenditure per capita in Education	0.086
	(0.0532)
Yearly expenditure per capita in Education Squared	-0.0003
	(0.0002)
Yearly regional per capita Capital Expenditure	-238.134
	(1711.9540)
Percentage of rural population	-10.305***
	(2.4525)
Ethnicity controls	
Nuwer	-57.340***
	(8.5779)

Anyiwak	-43.322***
	(10.3145)
Gumuz	-61.090***
	(9.1462)
Konso	-43.918
	(30.3276)
|Hist. Adv.	-13.080***
	(2.5029)
Somalie	-41.852***
	(3.4293)
Affar	-59.895***
	(4.0262)
Other Small	-13.747***
	(2.9050)
Time controls	
T zero	-12.542***
	(1.6965)
T one	-6.326***
	(1.7131)
T two	-4.323***
	(1.2316)
T three	Omitted
Constant	94.305***
	(4.2712)
Log Linear Regression	
Dependent variable: Antenatal Care	
Independent variables:	OLS
Log yearly expenditure per capita in Education	0.078**
	(0.0341)
Log yearly regional per capita Capital Expenditure	-36.054
	(47.8480)
Percentage of rural population	-0.011
	(0.0671)
Ethnicity controls	
Nuwer	-2.787***
	(0.2403)
Anyiwak	-0.807***
	(0.2774)
Gumuz	-1.290***
	(0.2545)
Konso	-0.579
	(0.8457)
|Hist. Adv.	-0.156**
	(0.0700)
Somalie	-0.901***
	(0.0961)
Affar	-1.839***
	(0.1127)
Other Small	-0.237***
	(0.0813)

Time controls	
T zero	-0.232***
	(0.0499)
T one	-0.150***
	(0.0496)
T two	-0.124 ***
	(0.0350)
T three	Omitted
Constant	4.249***
	(0.1706)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels

Linear Regression

Dependent variable: Contraceptive Acceptance rate

Independent variables:	OLS
Yearly expenditure per capita in Education	-0.052*
	(0.0287)
Yearly regional per capita Capital Expenditure	-1371.507
	(1583.1580)
Percentage of rural population	-11.900***
	(2.2773)
Ethnicity controls	
Nuwer	-64.900***
	(7.8045)
Anyiwak	-45.951***
	(9.5779)
Gumuz	-57.212***
	(8.3646)
Konso	-10.295
	(28.6759)
|Hist. Adv.	-5.363**
	(2.3429)
Somalie	-61.431***
	(3.302)
Affar	-53.855***
	(3.7462)
Other Small	-12.126***
	(2.7181)
Time controls	
T zero	-14.651***
	(1.4963)
T one	-8.743***
	(1.4947)
T two	-3.260***
	(1.0739)

T three	Omitted
Constant	83.648*** (3.7609)
Quadratic Regression	
Dependent variable: Contraceptive Acceptance rate	
Independent variables:	OLS
Yearly expenditure per capita in Education	-0.012 (0.0493)
Yearly expenditure per capita in Education Squared	-0.00023 (0.0002)
Yearly regional per capita Capital Expenditure	-1351.924 (1583.894)
Percentage of rural population	-11.527*** (2.3092)
Ethnicity controls	
Nuwer	65.492*** (7.8317)
Anyiwak	-45.000*** (9.6311)
Gumuz	-57.931*** (8.4008)
Konso	-11.154 (28.7083)
|Hist. Adv.	-5.396** (2.3444)
Somalie	-61.430*** (3.3037)
Affar	-54.207*** (3.7654)
Other Small	-12.297*** (2.7251)
Time controls	
T zero	-14.187*** (1.5666)
T one	-8.350*** (1.5451)
T two	-3.075*** (1.0896)
T three	Omitted
Constant	82.290*** (4.0021)
Log Linear Regression	
Dependent variable: Contraceptive Acceptance rate	
Independent variables:	OLS
Log yearly expenditure per capita in Education	-0.025 (0.0403)
Log yearly regional per capita Capital Expenditure	-59.955 (55.6050)

Percentage of rural population	-0.124
	(0.0799)
Ethnicity controls	
Nuwer	-4.864***
	(0.2766)
Anyiwak	-1.777***
	(0.3285)
Gumuz	-1.813***
	(0.2954)
Konso	-0.111
	(1.0139)
|Hist. Adv.	-0.073
	(0.0828)
Somalie	-2.786***
	(0.1169)
Affar	-2.134***
	(0.1332)
Other Small	-0.325***
	(0.0963)
Time controls	
T zero	-0.385***
	(0.0579)
T one	-0.258***
	(0.0559)
T two	-0.0938**
	(0.0385)
T three	Omitted
Constant	4.481***
	(0.2021)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels

Linear Regression

Dependent variable: Delivery by Skilled Birth Attendant

Independent variables:	OLS
Yearly expenditure per capita in Education	0.066***
	(0.0287)
Yearly regional per capita Capital Expenditure	328.600
	(1211.0980)
Percentage of rural population	-22.745***
	(1.7421)
Ethnicity controls	
Nuwer	-15.830***
	(5.9881)
Anyiwak	-19.264***
	(7.4207)
Gumuz	-17.340***
	(6.2405)

Konso	-3.805
	(20.9835)
|Hist. Adv.	-4.326**
	(1.7805)
Somalie	-10.021***
	(2.5271)
Affar	-9.327***
	(2.8013)
Other Small	-5.143**
	(2.0568)
Time controls	
T zero	-3.308***
	(1.1900)
T one	-4.626***
	(1.2333)
T two	1.012
	(0.9168)
T three	Omitted
Constant	40.980***
	(2.8922)

Quadratic Regression

Dependent variable: Delivery by Skilled Birth Attendant

Independent variables:	OLS
Yearly expenditure per capita in Education	0.068*
	(0.0389)
Yearly expenditure per capita in Education Squared	-0.00001
	(0.0001)
Yearly regional per capita Capital Expenditure	330.274
	(1211.889)
Percentage of rural population	-22.726***
	(1.7685)
Ethnicity controls	
Nuwer	-15.862***
	(6.0100)
Anyiwak	-19.204**
	(7.4858)
Gumuz	-17.374***
	(6.2652)
Konso	-3.847
	(21.0059)
|Hist. Adv.	-4.327**
	(1.7815)
Somalie	-10.024***
	(2.5288)
Affar	-9.344***
	(2.8147)
Other Small	-5.152**
	(2.0616)
Time controls	
T zero	-3.285***

	(1.2422)
T one	-4.607***
	(1.2694)
T two	1.021
	(0.9270)
T three	Omitted
Constant	40.911***
	(3.0919)
Log Linear Regression	
Dependent variable: Delivery by Skilled Birth Attendant	
Independent variables:	OLS
Log yearly expenditure per capita in Education	0.243***
	(0.0732)
Log yearly regional per capita Capital Expenditure	-72.666
	(98.6972)
Percentage of rural population	-0.705***
	(0.1456)
Ethnicity controls	
Nuwer	-2.556***
	(0.5012)
Anyiwak	-2.182***
	(0.5980)
Gumuz	-1.106**
	(0.5242)
Konso	-0.223
	(1.7985)
|Hist. Adv.	0.019
	(0.1486)
Somalie	-0.758***
	(0.2109)
Affar	-1.310***
	(0.2378)
Other Small	-0.186
	(0.1726)
Time controls	
T zero	-0.123
	(0.1011)
T one	-0.408***
	(0.0990)
T two	-0.000
	(0.0700)
T three	Omitted
Constant	2.477***
	(0.3672)

Probit regressions with robust standard errors in parentheses; Predicted probabilities with unconditional standard errors in parentheses.
*, **, *** = coefficients significant at the 10%, 5% and 1% levels

Stage 1: Agriculture

Log Linear Regression

Dependent variable: Cereal Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	0.128***
	(0. 0489)
Percentage of rural population	-0.414*
	(0.2205)
Rainfall controls	
Average rainfall	0.000
	(0.0008)
Deviation from average rainfall	0.001**
	(0.0007)
Deviation from average rainfall (lagged)	0.002***
	(0.0007)
Regional dummies	
Tigray	4.576
	(9.0103)
Afar	3.544
	(8.5370)
Amhara	3.522
	(8.9863)
Oromia	3.951
	(8.9503)
Somali	11.307
	(9.2046)
Beneshangul Gemuz	17.258
	(18.0467)
SNNP	3.502
	(8.9883)
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	0.000
	(0.0009)
Afar x Avg RF	Omitted
Amhara x Avg RF	0.000
	(0.0009)
Oromia x Avg RF	0.000
	(0.0008)
Somali x Avg RF	-0.010***
	(0.0027)
Beneshangul Gemuz x Avg RF	-0.011
	(0.0128)
SNNP x Avg RF	0.000
	(0.0008)
Gambella x Avg RF	Omitted

Regional dummies x Poverty rate	
Tigray x Poverty rate	-0.020
	(0.0182)
Afar x Poverty rate	Omitted
Amhara x Poverty rate	-0.003
	(0.0058)
Oromia x Poverty rate	0.002
	(0.0063)
Somali x Poverty rate	-0.078***
	(0.0200)
Beneshangul Gemuz x Poverty rate	-0.036
	(0.0438)
SNNP x Poverty rate	0.000
	(0.0025)
Gambella x Poverty rate	0.102
	(0.2498)
Constant	-1.510
	(8.9315)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression

Dependent variable: Pulses Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	-0.020
	(0.0645)
Percentage of rural population	0.105
	(0.2456)
Rainfall controls	
Average rainfall	0.001
	(0.0014)
Deviation from average rainfall	0.001
	(0.0010)
Deviation from average rainfall (lagged)	0.001
	(0.0010)
Regional dummies	
Tigray	3.165
	(2.126)
Afar	0.918
	(1.1132)
Amhara	2.115
	(1.9126)
Oromia	3.184*
	(1.8845)
Somali	3.569
	(3.0569)
Beneshangul Gemuz	39.151* (20.4730)
SNNP	2.462

	(1.9117)
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	-0.001
	(0.0015)
Afar x Avg RF	Omitted
Amhara x Avg RF	0.000
	(0.0014)
Oromia x Avg RF	-0.001
	(0.0014)
Somali x Avg RF	-0.002
	(0.0036)
Beneshangul Gemuz x Avg RF	-0.030*
	(0.0166)
SNNP x Avg RF	-0.001
	(0.0014)
Gambella x Avg RF	Omitted
Regional dummies x Poverty rate	
Tigray x Poverty rate	-0.012
	(0.0196)
Afar x Poverty rate	Omitted
Amhara x Poverty rate	-0.008
	(0.0063)
Oromia x Poverty rate	-0.010
	(0.0070)
Somali x Poverty rate	-0.027
	(0.0265)
Beneshangul Gemuz x Poverty rate	-0.126**
	(0.0563)
SNNP x Poverty rate	0.002
	(0.0027)
Gambella x Poverty rate	Omitted
Constant	-0.213
	(1.8785)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression	
Dependent variable: Root Crop Yield	
Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	0.320
	(0.2266)
Percentage of rural population	-0.082
	(0.7218)
Rainfall controls	

Average rainfall	0.000
	(0.0032)
Deviation from average rainfall	0.002
	(0.0039)
Deviation from average rainfall (lagged)	0.010
	(0.0039)
Regional dummies	
Tigray	0.739
	(5.2598)
Afar	Omitted
Amhara	0.314
	(4.4270)
Oromia	0.579
	(4.4138)
Somali	-1.041
	(5.5139)
Beneshangul Gemuz	4.842
	(43.2237)
SNNP	0.626
	(4.4447)
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	0.000
	(0.0036)
Afar x Avg RF	Omitted
Amhara x Avg RF	0.000
	(0.0033)
Oromia x Avg RF	0.000
	(0.0033)
Somali x Avg RF	0.003
	(0.0069)
Beneshangul Gemuz x Avg RF	-0.003
	(0.0351)
SNNP x Avg RF	0.000
	(0.0033)
Gambella x Avg RF	Omitted
Regional dummies x Poverty rate	
Tigray x Poverty rate	0.012
	(0.0618)
Afar x Poverty rate	Omitted
Amhara x Poverty rate	-0.008
	(0.0170)
Oromia x Poverty rate	-0.009
	(0.0211)
Somali x Poverty rate	Omitted
Beneshangul Gemuz x Poverty rate	-0.006

	(0.1203)
SNNP x Poverty rate	-0.016**
	(0.0074)
Gambella x Poverty rate	Omitted
Constant	2.431
	(4.5185)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression

Dependent variable: Vegetable Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	0.582***
	(0.1330)
Percentage of rural population	-0.110
	(0.5548)
Rainfall controls	
Average rainfall	0.001
	(0.0021)
Deviation from average rainfall	0.001
	(0.0020)
Deviation from average rainfall (lagged)	-0.003
	(0.0021)
Regional dummies	
Tigray	32.703
	(22.4893)
Afar	34.322
	(22.5041)
Amhara	32.568
	(22.4326)
Oromia	33.773
	(22.3465)
Somali	10.227
	(22.9840)
Beneshangul Gemuz	35.983
	(43.4964)
SNNP	31.791
	(22.4365)
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	-0.002
	(0.0024)
Afar x Avg RF	-0.005
	(0.0042)
Amhara x Avg RF	-0.002
	(0.0022)
Oromia x Avg RF	-0.002
	(0.0021)

Somali x Avg RF	0.031***
	(0.0067)
Beneshangul Gemuz x Avg RF	-0.005
	(0.0306)
SNNP x Avg RF	0.001
	(0.0021)
Gambella x Avg RF	Omitted
Regional dummies x Poverty rate	
Tigray x Poverty rate	0.004
	(0.0618)
Afar x Poverty rate	Omitted
Amhara x Poverty rate	-0.003
	(0.0145)
Oromia x Poverty rate	-0.034**
	(0.0159)
Somali x Poverty rate	0.185***
	(0.0490)
Beneshangul Gemuz x Poverty rate	-0.036
	(0.1049)
SNNP x Poverty rate	-0.004
	(0.0064)
Gambella x Poverty rate	0.919
	(0.6237)
Constant	-29.575
	(22.3062)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression

Dependent variable: Oil seeds Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	-0.118
	(0.1899)
Percentage of rural population	-0.229
	(0.6220)
Rainfall controls	
Average rainfall	-0.008***
	(0.0024)
Deviation from average rainfall	-0.001
	(0.0034)
Deviation from average rainfall (lagged)	-0.001
	(0.0036)
Regional dummies	
Tigray	-43.523*
	(25.2816)
Afar	-38.156
	(24.0540)

	Amhara	-42.608*
		(25.2609)
	Oromia	-42.904*
		(25.1993)
	Somali	-41.315*
		(24.3306)
	Beneshangul Gemuz	-52.981
		(44.3822)
	SNNP	-44.061*
		(25.2585)
	Gambella	Omitted
Regional dummies x Average rainfall		
	Tigray x Avg RF	0.008***
		(0.0027)
	Afar x Avg RF	Omitted
	Amhara x Avg RF	0.008***
		(0.0025)
	Oromia x Avg RF	0.008***
		(0.0025)
	Somali x Avg RF	Omitted
	Beneshangul Gemuz x Avg RF	0.017***
		(0.0025)
	SNNP x Avg RF	0.009***
		(0.0025)
	Gambella x Avg RF	Omitted
Regional dummies x Poverty rate		
	Tigray x Poverty rate	0.017
		(0.0450)
	Afar x Poverty rate	Omitted
	Amhara x Poverty rate	0.001
		(0.0144)
	Oromia x Poverty rate	0.007
		(0.0186)
	Somali x Poverty rate	Omitted
	Beneshangul Gemuz x Poverty rate	0.012
		(0.1041)
	SNNP x Poverty rate	0.000
		(0.7084)
	Gambella x Poverty rate	-1.044*
		(0.7084)
Constant		45.731*
		(25.1903)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression

Dependent variable: Enset Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	2.397***
	(0. 5766)
Percentage of rural population	-1.091
	(1.7449)
Rainfall controls	
Average rainfall	0.000
	(0.0011)
Deviation from average rainfall	0.010
	(0.0168)
Deviation from average rainfall (lagged)	0.068***
	(0.0157)
Regional dummies	
Tigray	Omitted
Afar	Omitted
Amhara	Omitted
Oromia	8.654***
	(3.0691)
Somali	Omitted
Beneshangul Gemuz	Omitted
SNNP	1.357
	(1.4055)
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	Omitted
Afar x Avg RF	Omitted
Amhara x Avg RF	Omitted
Oromia x Avg RF	-0.005***
	(0.0016)
Somali x Avg RF	Omitted
Beneshangul Gemuz x Avg RF	Omitted
SNNP x Avg RF	Omitted
Gambella x Avg RF	Omitted
Regional dummies x Poverty rate	
Tigray x Poverty rate	Omitted
Afar x Poverty rate	Omitted
Amhara x Poverty rate	Omitted
Oromia x Poverty rate	-0.034
	(0.0527)
Somali x Poverty rate	Omitted
Beneshangul Gemuz x Poverty rate	Omitted
SNNP x Poverty rate	0.020***
	(4.3094)
Gambella x Poverty rate	-1.044*
	(0.7084)
Constant	-13.452***
	(4.3094)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression

Dependent variable: Fruit Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	1.790***
	(0.2669)
Percentage of rural population	-0.794
	(0.9149)
Rainfall controls	
Average rainfall	0.000
	(0.0006)
Deviation from average rainfall	0.002
	(0.0048)
Deviation from average rainfall (lagged)	0.028***
	(0.0050)
Regional dummies	
Tigray	-2.459
	(3.3924)
Afar	4.850*
	(2.8878)
Amhara	-0.309
	(0.9558)
Oromia	2.933**
	(1.2536)
Somali	-5.032
	(6.4944)
Beneshangul Gemuz	-108.598**
	(55.213)
SNNP	Omitted
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	0.001
	(0.0019)
Afar x Avg RF	-0.009
	(0.0059)
Amhara x Avg RF	0.001
	(0.0013)
Oromia x Avg RF	-0.002**
	(0.0008)
Somali x Avg RF	0.005
	(0.0090)
Beneshangul Gemuz x Avg RF	0.087*
	(0.0448)
SNNP x Avg RF	Omitted
Gambella x Avg RF	Omitted
Regional dummies x Poverty rate	
Tigray x Poverty rate	0.002
	(0.0665)
Afar x Poverty rate	Omitted
Amhara x Poverty rate	-0.023
	(0.0213)
Oromia x Poverty rate	-0.019
	(0.0267)

Somali x Poverty rate	0.113
	(0.0727)
Beneshangul Gemuz x Poverty rate	0.288*
	(0.1537)
SNNP x Poverty rate	0.014
	(0.0093)
Gambella x Poverty rate	Omitted
Constant	-4.019***
	(1.4968)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Log Linear Regression

Dependent variable: Coffee Yield

Independent variables:	OLS
Log yearly expenditure per capita in Agriculture	1.267***
	(0. 2342)
Percentage of rural population	-0.777
	(0.7845)
Rainfall controls	
Average rainfall	0.000
	(0.0005)
Deviation from average rainfall	-0.001
	(0.0048)
Deviation from average rainfall (lagged)	0.029***
	(0.0049)
Regional dummies	
Tigray	Omitted
Afar	Omitted
Amhara	-0.632
	(0.8110)
Oromia	2.014*
	(1.0696)
Somali	1.43**
	(0.6380)
Beneshangul Gemuz	-18.760
	(46.6977)
SNNP	Omitted
Gambella	Omitted
Regional dummies x Average rainfall	
Tigray x Avg RF	Omitted
Afar x Avg RF	Omitted
Amhara x Avg RF	0.000
	(0.0011)
Oromia x Avg RF	-0.001***
	(0.0007)

Somali x Avg RF	Omitted
Beneshangul Gemuz x Avg RF	0.014
	(0.0379)
SNNP x Avg RF	Omitted
Gambella x Avg RF	Omitted
Regional dummies x Poverty rate	
Tigray x Poverty rate	Omitted
Afar x Poverty rate	Omitted
Amhara x Poverty rate	-0.012
	(0.0180)
Oromia x Poverty rate	0.004
	(0.0228)
Somali x Poverty rate	Omitted
Beneshangul Gemuz x Poverty rate	0.068
	(0.1300)
SNNP x Poverty rate	0.007
	(0.0082)
Gambella x Poverty rate	Omitted
Constant	-4.095***
	(1.3591)

Cross-time pooled regressions with robust standard errors; standard errors in parentheses;
*, **, *** = coefficients significant at the 10%, 5% and 1% levels
Dire Dawa and Hara omitted due to small scale of agriculture in these regions

Stage 3: Agriculture

Dependent variable: Any Improved Technique, 2011

Independent variables:	Probit	Predicted Probability
Yearly expenditure per capita in Agriculture	0.0033	
	(0.00029)	
Poverty rate	0.0075**	
	(0.00295)	
Rainfall controls		
Average rainfall	-0.00078***	
	(0.00007)	
Deviation from average rainfall 2011	-0.00306***	
	(0.00046)	
Deviation from average rainfall 2010	0.0090***	
	(0.00043)	
Regional dummies		
Tigray	omitted	
Afar	-5.1478***	
	(0.58951)	
Amhara	-2.8538***	
	(0.13734)	
Oromia	-0.02614	
	(0.14042)	
Somali	-1.1050 (2.79749)	

	Beneshangul Gemuz	-28.8422***	
		(5.38058)	
	SNNP	-0.9599 (0.14272)	
	Gambella	40.0622	
		-	
Regional dummies x Average rainfall			
	Tigray x Avg RF	omitted	
	Afar x Avg RF	omitted	
	Amhara x Avg RF	0.0031***	
		(0.00007)	
	Oromia x Avg RF	-0.00001	
		(0.00007)	
	Somali x Avg RF	-0.0025 (0.00408)	
	Beneshangul Gemuz x Avg RF	0.0234***	
		(0.00434)	
	SNNP x Avg RF	0.0005***	
		(0.00008)	
	Gambella x Avg RF	0.0022***	
		0.00066	
Regional dummies x Poverty rate			
	Tigray x Poverty rate	omitted	
	Afar x Poverty rate	0.1298***	
		(0.01668)	
	Amhara x Poverty rate	-0.0027 (0.00304)	
	Oromia x Poverty rate	-0.0207***	
		(0.00307)	
	Somali x Poverty rate	-0.0016 (0.02692)	
	Beneshangul Gemuz x Poverty rate	0.0446***	
		(0.01563)	
	SNNP x Poverty rate	-0.0010 (0.00298)	
	Gambella x Poverty rate	-1.4040	
		-	
Quintile			
	Smallest/Poorest	omitted	0.0003***
			(0.00002)
	Second/Poorer	0.0445***	0.0003***
		(0.01386)	(0.00003)
	Middle/Middle	0.3727***	0.0005***
		(0.01282)	(0.00004)
	Fourth/Richer	0.5961***	0.0006***
		(0.01265)	(0.00005)
	Largest/Richest	0.8211***	0.0008***
		(0.01280)	(0.00007)
Constant		-1.7225***	
		(0.15902)	