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Investigating Economywide and Household-Level Impacts of Sector-Specific Shocks in a Poor Country

The Case of Avian Flu in Ethiopia

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ABSTRACT

Do the economic effects of potential avian flu outbreaks justify policy attention and resource allocation in a poor country like Ethiopia? We address this question by assessing both economywide (macro-level) economic impacts and household (micro-level) livelihood impacts that might be caused by an avian flu outbreak in Ethiopia. Because 1) the prevalent traditional poultry sector is weakly linked to other sectors, 2) livelihoods of the poultry-producing households are diversified, and 3) shocks are idiosyncratic in nature, the study finds that the impacts of an avian flu outbreak are likely to be small and limited to producers who keep larger flocks. Therefore, allotment of funds to prevent the disease must be justified on the grounds of preventing spread of the disease to human populations in Ethiopia and in other countries where it might have more severe economic and health effects. In other words, resource allocation must be justified as a global public good.

Keywords: avian flu, livelihoods, multimarket model, simulations, probit, zero-inflated negative binomial, propensity score matching

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1. INTRODUCTION

Ethiopia supports one of the largest livestock populations in Africa (Alemu et al. 2008). The livestock sector accounts for 19 percent of national GDP and as much as 40 percent of agricultural GDP (FAO 2004). At a micro level, it has been estimated that livestock supports the livelihoods of about 80 percent of the rural population in Ethiopia (FAO 2004). Indigenous birds comprise almost all of the country's 34 million bird population (94 percent), which implies that the poultry subsector is characterized by traditional, small-scale, household-level production (CSA 2005; Alemu et al. 2008).

In Ethiopia, traditional, small-scale, household-level poultry production (also known as backyard or village-level poultry keeping) is defined as having little input of feed (birds primarily scavenge for food) and veterinary services, almost no investment in housing (hence a minimal level of biosecurity since birds without appropriate housing are at greater risk of being exposed to diseases), and consequently, high poultry mortality rates. This system does not involve investments beyond the cost of the foundation stock, a few handfuls of local grains, and possibly simple night shades or nighttime housing in family dwellings (Alemu et al. 2008).

Few studies have investigated the role of household-level poultry keeping in rural livelihoods. The studies that have are based mainly on qualitative or quantitative data generated through rapid assessment techniques, and they show that the traditional poultry sector contributes to various livelihood outcomes in Ethiopia, including cash income and food and nutrition security. Poultry has also been found to play an important role in cultural, religious, and traditional practices (Tadelle and Ogle 2001; Tadelle et al. 2003; Bush 2006).

While Ethiopia has not yet experienced an outbreak of Highly Pathogenic Avian Influenza (HPAI), there was an avian flu scare in 2006. This scare caused a significant demand shock that led to a sharp decline in poultry prices (Alemu et al. 2008). In the same year, a three-year preparedness plan for avian flu, worth US$124 million, was approved by the Ethiopian government and international agencies. This is a significant sum, equaling almost 10 percent of the total Organization for Economic Cooperation and Development (OECD) aid to Ethiopia in 2007 (OECD StatExtrcat 2010).

There is, however, no evidence-based information regarding whether or not the macro- and micro-level economic impacts likely to arise from an avian flu outbreak justify such an allocation. To the best of our knowledge, the only study that has investigated the economic impacts of the 2006 scare is Bush (2006), which is based on qualitative data collected from one region of the country, namely the Southern Nations, Nationalities, and People's Region (SNNPR). Bush reports that the avian flu shock was particularly severe in urban areas, where poultry demand decreased by 25–30 percent. As a result of the reduction in urban demand and the subsequent oversupply, poultry prices dropped 50–60 percent, though this plunge was short-lived (Bush 2006).

The aim of this paper is to investigate the economic impacts of an avian flu outbreak on the overall economy as well as on poultry-producing households in Ethiopia. We investigate the economywide impacts by using a spatially disaggregated multimarket model (Diao and Nin Pratt 2007) and the household-level impacts by using a matching approach that allows us to estimate the ex ante effects (Caliendo and Kopeinig 2008). For both models, we use nationally representative datasets in order to assess regional differences.

Assessment of the macro-level economywide impacts indicates that the Ethiopian poultry sector is composed of a very large, traditional, small-scale, household-level poultry sector aimed at household consumption and hence with weak intersectoral linkages. This large traditional sector operates alongside a small, modern, large-scale poultry sector that is linked with other sectors, most notably the feed sector. For the economywide analysis, we deliberately simulated large demand and supply shocks (resulting in at least a 40 percent drop in quantity demanded). The results reveal that economywide impacts of an avian flu outbreak are likely to be small in Ethiopia. If these hypothetically large shocks do not result in any significant impacts, we can argue that neither would smaller shocks. The results hold even when significantly higher growth rates are assigned to the modern poultry sector, as the modern sector has a small share to begin with. However, when compared with the results from the macro-level analysis, household-level livelihood impacts of an avian flu outbreak are expected to be significant.

For the assessment of the micro-level livelihood impacts of an avian flu outbreak, we first profile households to determine which households are likely to keep poultry and, of those, which are likely to keep larger flocks, since livelihoods of the latter group of households would be most vulnerable to an avian flu outbreak. We find that traditional, small-scale poultry producers have diversified livelihood portfolios. They are likely to keep other types of livestock and to engage in several income-generating activities in addition to keeping livestock. Finally, the impact assessment of an avian flu outbreak on expenditures and livestock wealth of poultry producers reveals that small-scale poultry-producing households that keep larger flocks are the only ones that are somewhat vulnerable to the effects of an avian flu outbreak. It should be noted, however, that the so-called "large-scale" poultry producers include all households with more than two birds. The average flock size of these "larger" producers is still quite small—only seven birds.

Note that the impact of the disease is multi-faceted, and the potential for loss of human life is one of the foremost concerns in the case of an HPAI outbreak. Through our analysis of economic effects, we can argue ex post that the rationale for investment in disease control in the case of HPAI has to be grounded in those human effects. In places like Indonesia and Nigeria, human deaths from HPAI have occurred to varying degrees; whatever form the disease takes in the case of Ethiopia, the potential for human mortality could drive most of the investments into HPAI prevention and control strategies.

The paper is organized as follows. Section 2 presents the dynamic multimarket model and the results of the simulated avian flu shocks on poultry and other related sectors. Section 3 introduces econometric models used to profile households that are most likely to be affected by an avian flu outbreak and to measure the impacts of shocks that may be caused by an avian flu outbreak and presents the results of these models. The final section concludes the paper with policy implications.

2. ECONOMYWIDE EFFECTS OF AN AVIAN FLU OUTBREAK IN ETHIOPIA

2.1. Methodology and Data

To investigate the economywide impacts of an avian flu outbreak, we use the Ethiopian multimarket model developed by Diao and Nin Pratt (2007). This model contains 34 disaggregated agricultural sectors (28 crop and eight livestock sectors), as well as two aggregated nonagricultural sectors. Production and consumption of all 36 sectors are further disaggregated into 11 regions and subsequently into 56 zones.

The supply function is defined at the zonal level and depends on output prices and a productivity parameter; for crops, it is further identified as a yield and an area function. The data used to determine the supply function are derived from national agricultural sample surveys. The production of major staple crops and livestock involves a variety of technologies. For staple crops, modern inputs and their effects on crop productivity are captured through the identification of 15 different technologies. Maize production, for example, incorporates four primary modern inputs—fertilizer, improved seeds, pesticide, and irrigation (individually or jointly)—and also includes production without modern inputs.

For the eight livestock subsectors, the model uses differences in productivity levels and the requirement of feedgrains to distinguish between traditional and modern technologies. Modern technology is hence characterized by its link with the feed sector. The feedgrain demand by the sector that uses modern technology (henceforth the modern livestock sector) is a function of grain crop prices. The traditional technology is characterized by grazing or scavenging; consequently, the sector that uses this technology (henceforth the traditional livestock sector) has no backward linkages to the feed sector.

The demand function is also disaggregated to the zonal level and depends on prices and per capita income. Data used to determine the demand function are derived from the 1999/2000 Household Income, Consumption, and Expenditure (HICE) Survey of the Central Statistical Association (CSA) in Ethiopia (CSA 2000). Consumer demand is determined by income and prices. The demand function satisfies the budget constraint by imposing a homogeneity condition on the elasticities, ensuring that total expenditure on commodities equals rural or urban income at the zonal level.

An integrated national market is assumed, with different price levels across zones. The difference between a zonal-level price and a national market price (represented by the market price in Ethiopia's capital city of Addis Ababa) is defined as the marketing margin. National market prices for most commodities are endogenously determined by national-level supply and demand, as are zonal-level prices. The model generates a baseline that reflects a "business-as-usual" scenario of the Ethiopian economy over a 2003–15 timeline.

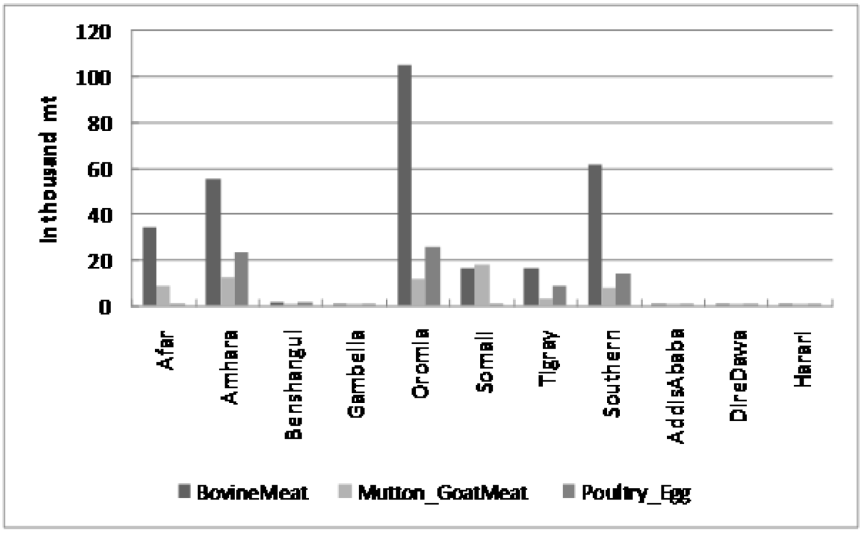
2.2. Baseline for Poultry Sector

According to the latest HICE (2004–05) data, overall, 50 percent of rural and 42 percent of urban households in Ethiopia keep poultry. Almost a quarter of poultry keepers are located in the Oromiya region, followed by Amhara (18 percent), SNNPR (14 percent), and Addis Ababa (13 percent). The size of flocks kept is very small, with five birds on average in both urban and rural areas.

As explained previously, the traditional poultry sector is largely characterized as having no backward linkages with the feedgrain sector. Moreover, this sector also has weak forward linkages, as only 23 percent of this sector's output is sold in the local or informal markets or at the farm gate (Alemu et al. 2008). In Ethiopia, the modern poultry sector comprises a few small- to medium-scale semi-commercial producers and even fewer large-scale commercial farms. These producers, especially large-scale farms, have strong backward and forward linkages in the economy. Most of these producers are located in Oromia and Addis Ababa. Large-scale commercial poultry farms involve a highly intensive production system with 10,000 or more birds kept under indoor conditions with a medium-to-high biosecurity level. This system depends heavily on imported exotic breeds that require inputs such as feed, housing, healthcare, and a modern management system (Alemu et al. 2008).

Figure 1 shows that for the year 2003, across all regions, bovine meat was the most important meat product. Poultry was the second most important meat in Amhara, Oromia, Tigray, and SNNPR. The highest demand and supply for poultry in Ethiopia was in the Oromia region. Note that the poultry sector as included in the model contains both meat and eggs production.

Figure 1. Demand (panel [a]) and supply (panel [b]) of poultry and other meats across regions in Ethiopia, in 1,000 metric tons (mt)



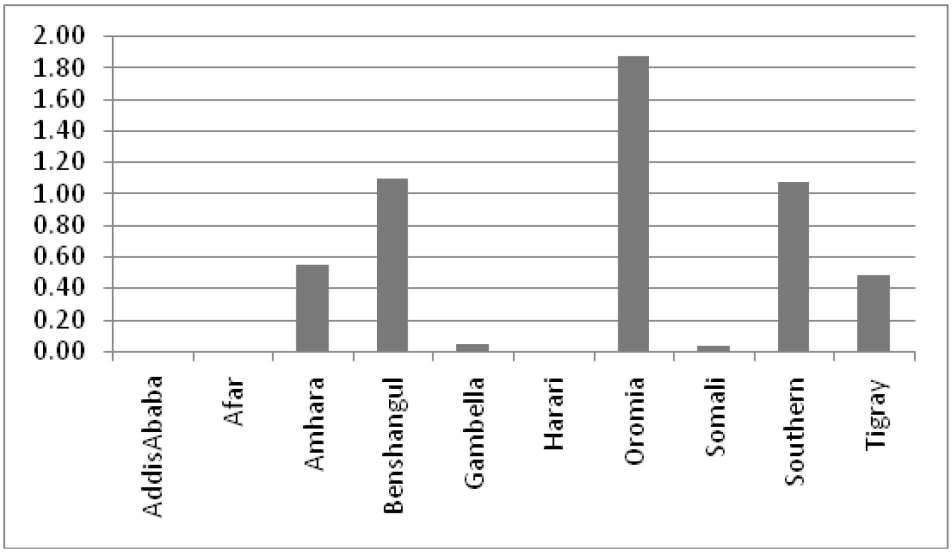
(a)

(b)

Source: Model baseline data.

The supply and demand differences across regions, as well as the differences across the modern and traditional poultry sectors, provide rationale for spatial disaggregation and disaggregation of the poultry into traditional and modern subsectors. Figure 2 reveals that the regional demand for maize (main feedgrain for poultry production) parallels the regional demand and supply patterns for poultry in Ethiopia, although the share of poultry feed in maize is generally insignificant.

Figure 2. Regional poultry feed demand in Ethiopia: Maize (in 1,000 mt)



Source: Model baseline data

2.3. Shocks and Effects

We simulate three demand and three supply shocks. Demand shocks are assumed to be caused by reductions in demand due to consumer panic, while supply shocks are assumed to be caused by reductions in poultry supply as a result of disease mortality, control measures such as culling, or both. We rely on case study results and anecdotal evidence (Birol 2008) and assume the order of these shocks to be 40 percent. Specifically, the simulated shocks comprise the following.

- Simulation 1: Demand shock resulting in 40 percent reduction in quantity demanded in 2009.
- Simulation 2: Demand shock resulting in 40 percent reduction in quantity demanded in 2009 and 2010.
- Simulation 3: Demand shock resulting in 40 percent reduction in quantity demanded from 2009–11.
- Simulation 4: Supply shock resulting in 40 percent reduction in quantity demanded in 2009.
- Simulation 5: Supply shock resulting in 40 percent reduction in quantity demanded in 2009 and 2010.
- Simulation 6: Supply shock resulting in 40 percent reduction in quantity demanded from 2009–11.

The simulation results reflect percentage changes relative to the baseline for a particular year. An exogenous demand shock is captured as a change in the shift parameter, corresponding to a movement along the demand curves. The supply shock affects demand endogenously through changes in the determinants of demand (for example, prices), that is, through a movement along the demand curve following a movement along the supply curves. Hence, to generate the same profile of demand path, the supply shock needs to be much higher. By using this model, we conceptualize three main effects: 1) effects on the poultry sector at national, regional, and subsectoral levels, 2) effects on the horizontally linked livestock sectors, and 3) effects on the upstream feed sector.

The downstream effects of the traditional poultry sector are expected to be small since only 23 percent of this sector's output is marketed, as explained previously. The downstream effects of the modern poultry sector on sectors such as catering, agri-food, and organized retail cannot be captured in this model because of the aggregation of the final consumption sector. However, these downstream linkages are expected to be negligible. There is very little processing in agrifood sectors, while organized retail hardly exists in Ethiopia, except in Addis Ababa where a small number of supermarkets have recently opened (Alemu et al. 2008).

2.4. Simulation Results

2.4.1. Effects on the Poultry Sector

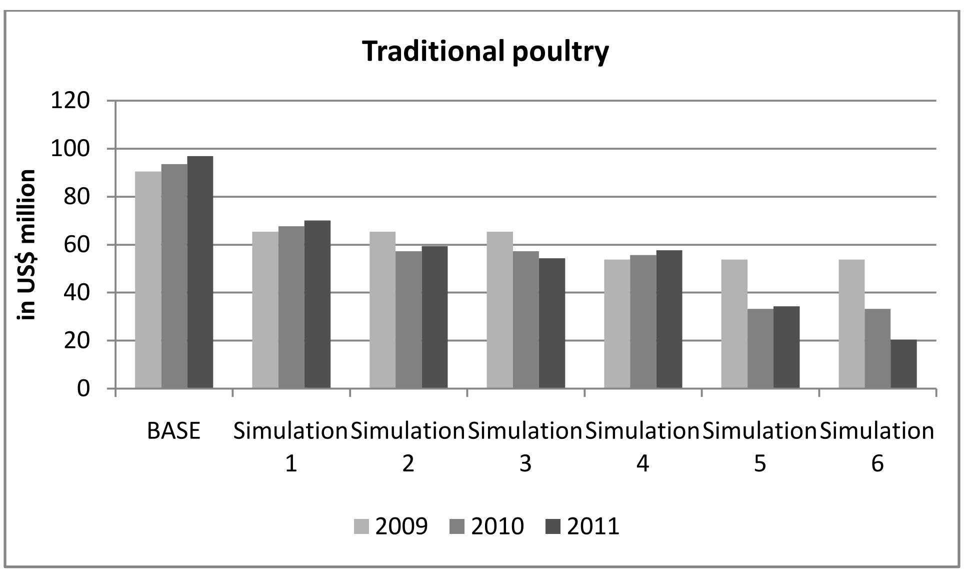
Table 1 reports the results from the six simulations on the value of production in the poultry sector in Ethiopia. Figure 3 depicts the changes in the value of production of the traditional and modern poultry sectors in Ethiopia under the same scenarios.

Table 1. Effects on the value of production of the poultry sector in Ethiopia, 2009–15

Simulation	2009	2010	2011	2012	2013	2014	2015
Baseline (US$ million)	95.62	98.86	102.23	105.73	109.38	113.17	117.12
Changes from baseline (%)							
Simulation 1	-27.73	-27.73	-27.69	-27.69	-27.66	-27.67	-27.67
Simulation 2	-27.73	-38.85	-38.79	-38.77	-38.73	-38.74	-38.73
Simulation 3	-27.73	-38.85	-43.96	-43.93	-43.86	-43.88	-43.86
Simulation 4	-40.54	-40.54	-40.55	-40.55	-40.56	-40.56	-40.56
Simulation 5	-40.54	-64.58	-64.59	-64.59	-64.59	-64.59	-64.60
Simulation 6	-40.54	-64.58	-78.87	-78.87	-78.88	-78.88	-78.88

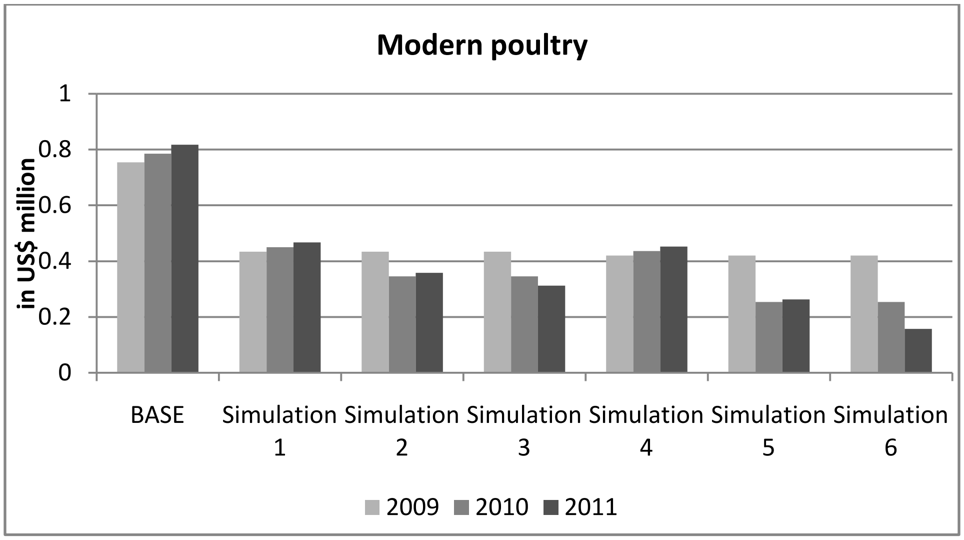
Source: Authors' simulation results.

Figure 3. Changes in value of production of traditional (panel [a]) and modern (panel [b]) poultry sectors in Ethiopia (in US$ million)



(a)

Figure 3. Continued

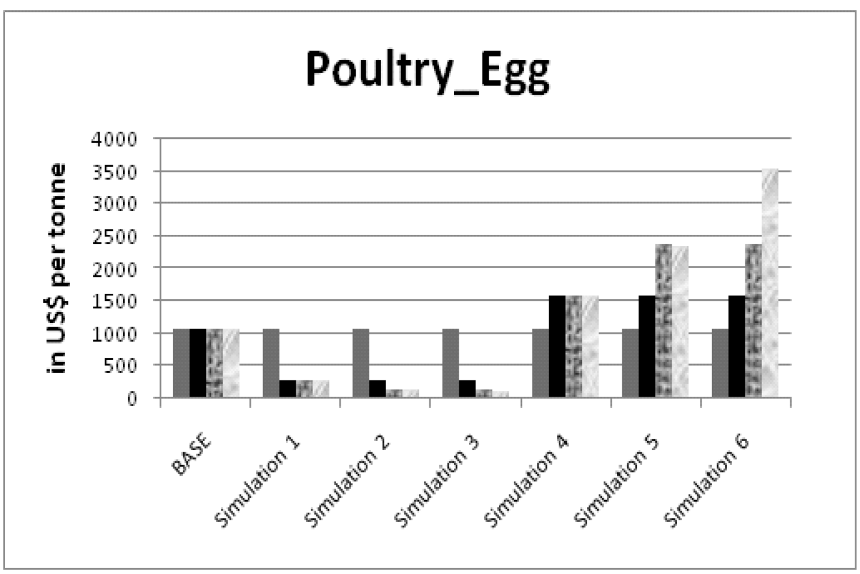


(b)

Source: Authors' simulation results.

The effect on the value of production works through changes in prices and in quantity. Both demand and supply shocks reduce the level of trade in the markets, but they have opposite effects on prices (Figure 4). Given that both demand and supply shocks would occur in the event of an outbreak, the actual impact will be bound by the effects of these two shocks.

Figure 4. Demand and supply shocks and their effect on national prices of poultry



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Source: Authors' simulation results.

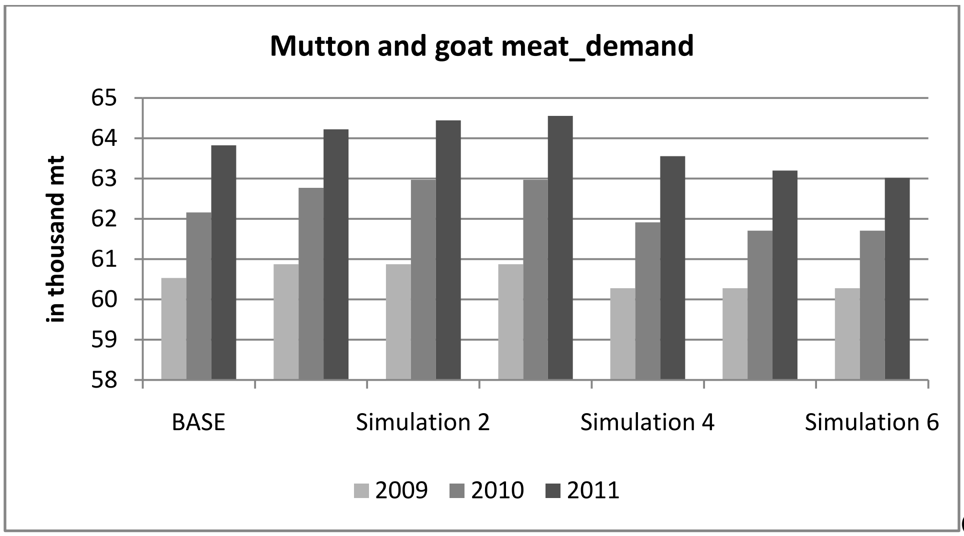
The effect on the value of poultry production is a direct function of the size of the poultry sector in each region. Hence, the changes in the value of production are the highest in the regions of Amhara, Oromia, Tigray, and SNNP. Other regions such as Afar and Harari have smaller poultry sectors and, consequently, would experience negligible changes in the value of poultry production.

In terms of prices, note that to begin with, there is limited price dispersion across regions (as there is regional self-sufficiency and no exports). Consequently, price dispersion across regions is expected to be limited after the shocks. Hence, the difference in value of production emanates mainly from differences in the output produced, which differs significantly across regions.

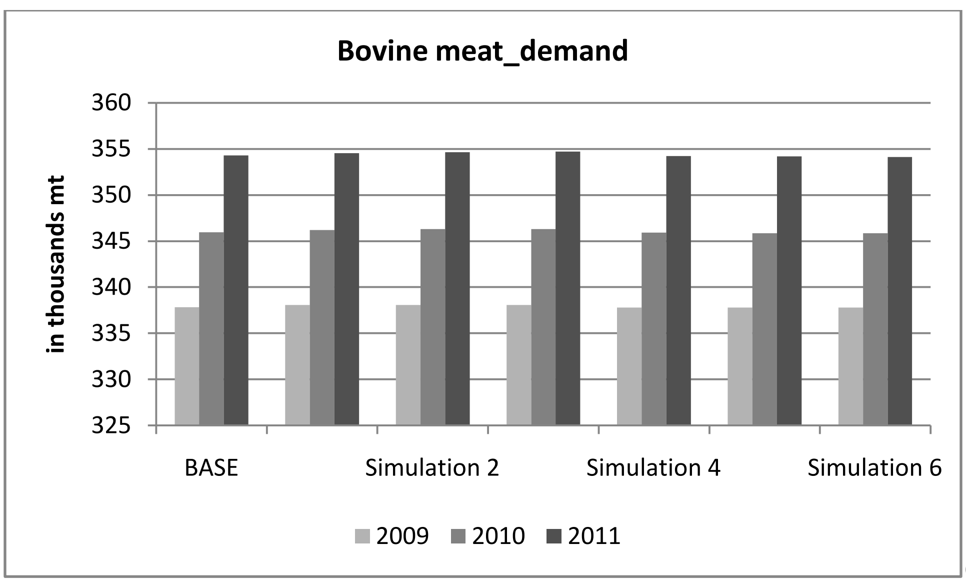
2.4.2. Effects on the Horizontally Linked Livestock Sectors

Both the traditional and the modern poultry sectors have horizontal linkages with other livestock sectors. Poultry produced in both sectors compete in the same fashion (for example, with bovine meat). Figures 5 and 6 show the effects of the different simulations on other livestock sectors.

Figure 5. Demand for mutton and goat meat (panel [a]) and bovine meat (panel [b]) under different shocks to the poultry sector (in 1,000 mt)



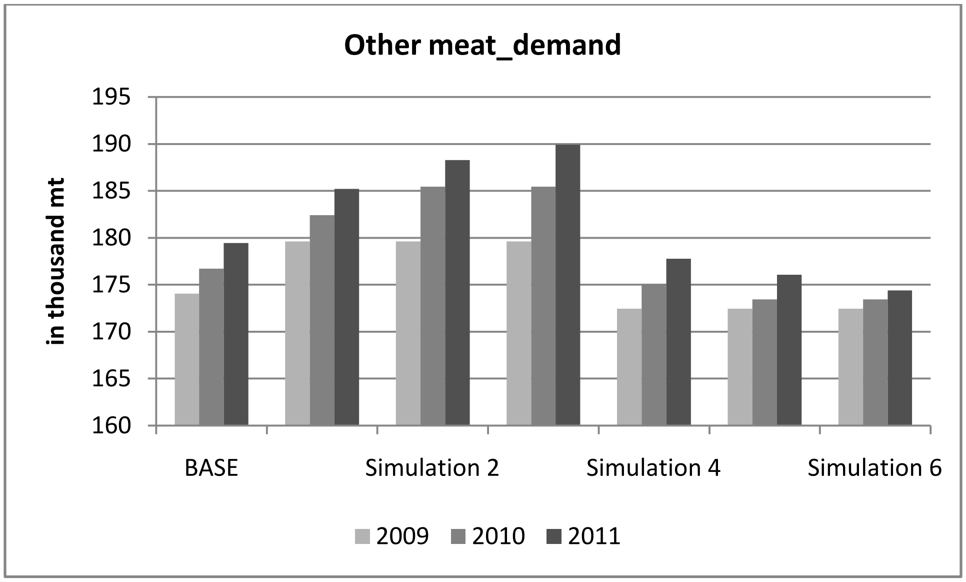
(a)



(b)

Source: Authors' simulation results.

Figure 6. Other meat demand under different shocks to the poultry sector (in 1,000 mt)



Source: Authors' simulation results.

As preferences shift away from poultry, other livestock sectors can experience an increase in demand for their product. When a price changes, there is a substitution effect (a shift away from poultry when prices rise) and an income effect, which reduces consumption of all items when prices rise (assuming goods are normal), while the opposite occurs when prices fall. Overall, Figures 5 and 6 show only a small effect on bovine meat from either a demand or a supply shock to the poultry sector but comparatively large effects on mutton and other meat product sectors (including pig meat and offal, preserves, and preparations of meat).

2.4.3. Effects on the Upstream Feed Sector

As we have explained, only the modern sector is assumed to have backward linkages with the feed sector, and the modern sector constitutes just a small fraction of the overall poultry sector. Consequently, vis-à-vis other livestock sectors, feed demand from the poultry sector represents only a small share of overall feed demand (Table 2). Only in rare cases is poultry feed demand the most important (maize and sorghum in Bensangul) or the second most important (maize in Amhara and Tigray) share of overall demand. Nevertheless, to the extent that shocks to poultry production affect the demand for other livestock products, there would be an effect on feed as a derived demand.

Table 2. Feed demand across sectors and regions in the baseline, 2003 (in 1,000 mt)

Region	Feed sector	Bovine meat	Mutton and goat meat	Poultry and eggs	Milk
Afar	Maize	0.03	0.06	0.001	0.07
	Sorghum	0.006	0.01	0.001	0.007
	Barley	neg.	0.0001	neg.	neg.
Amhara	Maize	0.70	0.40	0.54	19.01
	Sorghum	0.35	0.21	0.32	9.67
	Barley	0.16	0.08	0.10	5.84
	Pulses, other	0.20	0.07	0.09	8.04
Benshangul	Maize	0.29	0.56	1.09	0.40
	Sorghum	0.27	0.52	1.10	0.37
	Barley	0.005	0.007	0.003	0.005
	Pulses, other	neg.	0.0001	0.0001	0.0001
Gambella	Maize	0.15	0.25	0.046078	0.32
	Sorghum	0.02	0.04	0.009	0.06
	Pulses, other	neg.	neg.	neg.	neg.
Oromia	Maize	5.91	3.53	1.88	59.95
	Sorghum	1.46	0.81	0.48	14.77
	Barley	0.58	0.21	0.10	18.80
	Pulses, other	0.11	0.02	0.01	4.43
Somali	Maize	0.35	0.29	0.03	0.60
	Sorghum	0.07	0.10	0.012	0.11
	Barley	0.01	0.03	0.004	0.01
	Pulses, other	0.007	0.0001	neg.	0.01
Tigray	Maize	0.38	0.42	0.48	6.33
	Sorghum	0.35	0.40	0.47	5.28
	Barley	0.01	0.009	0.01	0.66
	Pulses, other	0.003	0.001	0.002	0.11
Southern	Maize	2.60	2.46	1.07	23.89
	Sorghum	0.27	0.35	0.13	1.73
	Barley	0.10	0.09	0.10	1.04
	Pulses, other	0.05	0.04	0.02	0.39
Addis Ababa	Maize	0.0004	neg.	neg.	0.02
	Barley	0.001	0.0001	neg.	0.05
	Pulses, other	0.002	0.0003	0.0001	0.11
Dire Dawa	Maize	0.001	0.002	0.05	0.003
	Sorghum	0.003	0.004	…	0.13
	Pulses, other	0.0004	0.0005	…-	0.01
Harari	Maize	0.001	0.001	0.001	0.04
	Sorghum	0.002	0.001	0.002	0.05

Source: Baseline data in the model derived from Federal Democratic Republic of Ethiopia. *Agricultural Census 2001/02*. Addis Ababa: Central Statistics Authority.

Overall, the results of the multimarket model reveal that in Ethiopia, the effects of an outbreak of avian flu will largely be concentrated in the poultry sector itself, with negligible effects on the Ethiopian economy at large. However, some changes that are underway, such as the growing modernization of the poultry sector, could make the economywide effects more pronounced. Because of this, we changed the relative growth of the modern and traditional sectors in the baseline, assigning a higher growth rate to the modern sector.[1] Even with a 30 percent higher growth rate for the modern sector, the overall effect of an outbreak of avian flu on the poultry sector continues to be negligible until 2015. Looking forward, it might be some time before the intersectoral linkages become important enough for an avian flu outbreak to produce significant economywide impacts in Ethiopia. However, for the same reasons that economywide effects could be small, the household-level livelihood impacts of avian flu could be substantial since household-level producers are largely engaged in the traditional poultry sector.

[1] Detailed results of these simulations are available from the authors upon request.

3. MICRO-LEVEL IMPACTS OF A POTENTIAL AVIAN FLU OUTBREAK ON LIVELIHOODS

3.1. Methodology and Data

In order to understand the impacts of an avian flu outbreak on livelihoods, we first identify the location and characteristics of households that are likely to keep poultry and those that are likely to keep larger flocks. It is hypothesized that, all things being equal, poultry-producing households, especially those with larger flocks and those that do not have diversified livelihood strategies, would be affected the most by the supply and demand shocks caused by an avian flu outbreak.

The determinants of a household's decision about whether or not to keep poultry (such as social, economic, and regional factors) are investigated with a probit model. Count data models are used to investigate the impacts of these factors on the household's decision about how many birds to keep. Following the results for overdispersion (Cameron and Trivedi 1990; Vuong 1989) and likelihood ratio tests, the zero-inflated negative binomial (ZINB) model is found to be the most appropriate count data model for describing the determinants of flock size.

Profiling of the characteristics of households engaged in poultry keeping provides only a qualitative sense of the effects of an avian flu outbreak on livelihoods. The whole income and asset portfolios of the household should be taken into account to quantify the livelihoods impacts. Since Ethiopia has not yet experienced an outbreak, ex post impact assessment is impossible. To estimate the livelihood impacts of a potential outbreak, we employ the propensity score matching (PSM) method, which has become a popular approach for estimating causal treatment effects (Caliendo and Kopeinig 2008).

The basic idea of PSM is to find a large group of control households that are similar to the treatment households in all relevant pretreatment characteristics. That being done, differences in outcomes for this well-selected and thus adequate control group and the treament group can be attributed to the treatment, which in this case is a state that can be associated with avian flu outbreak. In this study, we use the variation in households' poultry-keeping status and poultry flock size to create counterfactual scenarios. The analysis involves matching households in the treatment and control groups by using PSM, where the treatment and control groups correspond to different states of poultry keeping (for example, small versus large flock sizes). Comparing households that are similar in terms of observed characteristics but differ only in flock size provides an estimate of the effects of an outbreak on some livelihood-related outcome variables. Here we simulate six counterfactual scenarios, which consider the livelihood impacts of both demand and supply shocks on poultry keepers of different scales.

To conduct the analyses described above, we use a nationally representative HICE survey conducted in 2004–05 by the CSA of Ethiopia (CSA 2004). There are two advantages to using this data. First, having nationally representative data enables us to investigate regional or location-related variations, such as urban versus rural areas or high avian flu risk versus low risk regions. Second, this dataset provides information on an extensive set of characteristics that we can use for profiling and matching with the PSM method.

3.2. Profiling Poultry-Producing Households

The results of the probit model are reported in Table A1 in the Appendix. This model fits data well according to the likelihood ratio test, assigning 67 percent of predictions to the correct category. Those households with more than 50 percent probability of keeping poultry are predicted to be poultry keepers. Some of the important variables that can be expected to have a bearing on livelihood outcomes are presented in Table 3.

Table 3. Comparison of the livelihood diversification characteristics of predicted poultry keeping households versus predicted nonkeepers

	Predicted nonkeepers		Predicted keepers	
Household characteristics	Mean	Std. Dev	Mean	Std. Dev
Household below hardcore poverty line	0.96	0.20	0.96	0.20
Expenditure per capita	301.65	371.41	301.38	1,094.73
Number of household members in agriculture***	0.89	1.32	1.26	1.49
Number of household members in nonfarm sector***	0.87	1.03	0.71	0.96
Number of income sources***	1.03	0.48	1.07	0.46
Household raises cattle***	0.44	0.50	0.74	0.44
Household has pack animals (donkey/mule/horse/camel) ***	0.10	0.30	0.45	0.50
Household has plough animals (ox) ***	0.30	0.46	0.68	0.47
Household has small livestock (sheep and goat) ***	0.16	0.36	0.67	0.47
Number of plough animals (ox) ***	0.48	0.98	1.33	3.63

Source: HICE 2004–05.
Note: *** t-tests show significant differences between predicted keepers and nonkeepers of poultry at 1 percent significance level.

Predicted poultry keepers have significantly more diversified livelihood strategies than predicted nonkeepers. Specifically, predicted poultry keepers are significantly more likely to keep other types of livestock and have a significantly higher number of income sources, compared with predicted nonkeepers. Even though the expenditure per capita (as a proxy for income) and proportion of households below the hardcore poverty line do not significantly differ across the two groups, poultry keepers are more likely to be resilient in the face of shocks and stresses that may be caused by an avian flu outbreak, owing to their diversified livelihood portfolios (Ellis 2000).

Regionally, results show that on average, 60 percent of all Ethiopian households are predicted to keep poultry, this figure being 66 percent in rural areas and 53 percent in urban areas. Across regions, Tigray has the highest proportion of households predicted to keep poultry at 87 percent, followed by Afar (86 percent), Benishangul (71 percent), and Somale (65 percent). According to an avian flu spread risk map for Ethiopia (Stevens et al. 2009), regions considered to be high avian flu risk areas include Benishangul and Tigray, whereas Somale is designated as a mid-level risk area. Hence, greater proportions of rural households and those located in riskier areas are likely to be poultrykeepers.

3.3. Profiling Households Engaged in Intensive Poultry Production

The results of the ZINB models are reported in Table A.2 in the Appendix. The probabilistic ZINB model is used to predict the flock sizes for poultry-keeping households. According to these predictions, an average poultry-keeping household in Ethiopia is predicted to keep two birds, with a standard deviation of six. Theil's inequality coefficient, which compares predicted and actual flock sizes, is smaller (closer to zero) at 0.29, revealing that the model explains the data well. Households predicted to keep at least the mean number of birds are compared with households that are predicted to keep flocks with sizes below the predicted mean (Table 4).

Table 4. Comparison of the livelihood diversification characteristics of households predicted to keep above versus below the mean number of birds

	Mean and below flock size		Above mean flock size	
Household characteristic	Mean	Std. Dev	Mean	Std. Dev
Household below hardcore poverty line**	0.95	0.21	0.96	0.19
Expenditure per capita	306.02	456.69	295.59	1130.34
Number of household members in agriculture***	1.01	1.39	1.16	1.48
Number of household members in nonfarm sector**	0.82	1.00	0.78	1.02
Number of income sources*	1.05	0.47	1.06	0.46
Household raises cattle***	0.32	0.47	0.77	0.42
Household has pack animals (donkey/mule/horse/camel) ***	0.02	0.15	0.55	0.50
Household has plough animals (ox) ***	0.24	0.42	0.68	0.47
Household has small livestock (sheep and goats) ***	0.08	0.27	0.80	0.40
Number of plough animals (ox) ***	0.38	2.26	1.34	2.03

Source: HICE 2004–05.
Notes: *** t-tests show significant differences between predicted keepers and nonkeepers of poultry at 1 percent, ** 5 percent, and * 10 percent significance levels.

As with participation in poultry production (Table 3), households that have more diversified livelihood portfolios (that is, those with a higher number of income sources and those that are engaged in other livestock production) are more likely to keep flocks above average size. Households in Tigray, Somale, and Afar provinces are predicted to keep the largest flocks, with three birds on average.

3.4. Impact of Avian Flu on Poultry-keeping Households' Livelihoods

The impacts of an avian flu outbreak on livelihoods are quantified for two livelihood outcome variables, namely expenditure per capita (within household) and livestock wealth per year. We divide household-level poultry producers into two groups: "smaller" ones representing those with one or two birds and more intensive, "larger" small-scale producers with more than two birds but fewer than 500 birds, where 500 is the cutoff point for traditional, small-scale household-level poultry (Alemu et al. 2008). We also allocate the households into high or medium avian flu risk areas, based on the Stevens et al. (2009) disease spread risk map for Ethiopia.

Scenario 1 assumes a countrywide shock in which all poultry-keeping households experience a total loss of their poultry flock due to avian flu. Here, the outcomes of households with poultry are compared with those without poultry. Scenario 2 investigates the impact under the assumption that only those households with "smaller" small-scale flocks are affected and that they lose all of their flocks. Scenario 3 assumes that only "larger" small-scale producers are adversely affected by avian flu; they lose some of their birds and are left with a flock size similar to that of the "smaller" small-scale producers.

Scenario 4 assesses the impact of a demand (price) shock caused by an avian flu outbreak. We assume this shock would be countrywide. Here, of those households that sell chicken, we compare households that get higher prices (above the median chicken price) with those that get lower (below-median) prices.

Scenarios 5 and 6 use the avian flu spread map (Stevens et al. 2009). In Scenario 5, poultry-producing households located in areas with high spread risk are assumed to experience a total loss of their poultry flock. In Scenario 6, "larger" small-scale producers in mid-level risk areas are assumed to be adversely affected and to lose some of their birds, leaving them with a flock size similar to that of the "smaller" small-scale producers.

The variables used to generate the propensity scores satisfy the requirements of common support and balancing property that are required in propensity score matching. Common support requirement refers to the overlap in propensity score distribution between treatment and control groups such that matching is between comparable units. Balancing property requires that in terms of characteristics, the treatment and control groups are on average statistically similar along partitions of the propensity score distribution. The variables used to generate propensity scores include regional and household characteristics, such as education of the head of household, age of the head, household size, land, and livestock and other asset ownership. Following Abadie and Imbens (2008), we use nearest neighbor matching, which provides analytical standard errors and does not require bootstrapping.

Table 5. Estimated impact of avian flu under different scenarios (in Ethiopian birr [ETB][a])

Outcome variable	Scenario 1 - All Ethiopia Treatment: no poultry Control: poultry		Scenario 2 - All Ethiopia Treatment: no poultry Control: Small flock		Scenario 3 –All Ethiopia Treatment: small flock Control: large flock		Scenario 4– Poultry sellers in Ethiopia Treatment: low price Control: high price		Scenario 5 – High risk avian flu areas in Ethiopia Treatment: no poultry Control: poultry		Scenario 6 – Medium risk avian flu areas in Ethiopia Treatment: small flock Control: Large Flock	
	N	ATT[b]	n	ATT	n	ATT	N	ATT	n	ATT	n	ATT
Expenditure per capita	2,160	6.416 (21.863)	1695	-62.434 (60.049)	694	52.867 (36.798)	437	-10.931 (18.063)	1,316	6.526 (28.871)	279	25.276 (21.261)
Livestock wealth	2,160	-296.828 (197.677)	1695	57.190 (293.624)	694	-755.9*** (293.5)		312.261 (512.929)	1,316	86.362 (265.756)	279	-988.3* (547.6)

Source: Authors' estimations
Notes: Standard errors are in parentheses; [a] US$1=16.5 ETB (28, October, 2010); [b]TT is the average treatment effect on the treated;***-Significant at 1%; and *-Significant at 10%.

Results show that in most cases the effects of an avian flu outbreak on livelihoods are insignificant (Table 5). Only in Scenarios 3 and 6 are there significant reductions in livestock wealth. In Scenario 3, "larger" producers facing 75 percent flock loss would experience a 756 Ethiopian birr (ETB) or 51 percent reduction in their livestock wealth. In Scenario 6, if "larger" producers in mid-level risk areas lost 75 percent of their flock, their total livestock wealth would decrease by ETB988, resulting in a 31 percent reduction in their livestock wealth.

4. CONCLUSIONS AND POLICY IMPLICATIONS

In this paper, we assess the macro- and micro-level economic impacts of a potential avian flu outbreak in Ethiopia. The results of macro-level investigations reveal that the effects of an avian flu outbreak will largely be concentrated in the poultry sector itself. Due to the weak intersectoral linkages of poultry with other sectors (such as feed), the economywide impacts of an outbreak of avian flu are negligible in Ethiopia. On the livelihood side, we found that almost half of all Ethiopian households keep poultry; however, these households manage very small flocks, and poultry-keeping is one of several livelihood activities they undertake. Therefore, the impacts of avian flu shocks are expected to be insignificant for an average household, although some households that keep "larger" flocks (seven birds, on average) could experience a significant loss of 30–50 percent in livestock wealth.

What do these small economywide and household-level economic impacts imply for large-scale investments in disease prevention from a development perspective? The externality for other countries or regions, in which poultry could be more economically important and to which Ethiopia is linked either through bird flyways or through trade or other means, provides a case for allocating funds to prevent an avian flu outbreak at its origin. Because poultry keepers may be averse to reporting an outbreak that could have even a small effect on their livelihoods, their failure to report an outbreak could have a disproportionate effect on disease control. Therefore they need to be given some incentives to report any outbreak of disease.

Since macro- and micro-level economic impacts are likely to be small – if not insignificant – in our view, the rationale for allocation of funds and policy attention to this issue can be best understood in terms of the potential of the disease to transform into a human pandemic, the costs of which could be many times greater to the Ethiopian economy and to the world at large (Berhane and Tefera 2005). In fact, the main reason why generous amounts of global funds have been allocated to controlling avian flu is because of the fear of a human pandemic. Even if the possibility of transmission of the disease to humans could be reasonably discarded, poultry sectors in other countries linked to Ethiopia, whether through trade or through bird flyways, could be affected by the disease. In either situation—a human pandemic or transmission of the disease to other regions where poultry may be economically important—prevention of the disease would be a public good that could have benefits much larger than the economic costs in a poor country like Ethiopia.

APPENDIX: SUPPLEMENTARY TABLES

Table A.1. Probit Model: Factors that affect household participation in poultry production

Variable	Coefficient	Std. Err.	Marginal Effect
Age of household head (years)	-0.01**	0.00	-0.003
Age of household head squared (years)	0.00**	0.00	0.000
Household size	0.01	0.01	0.003
Proportion of female adults (15 years and up)	-0.12**	0.05	-0.046
Proportion of children (below 18 years)	-0.06	0.06	-0.025
Number of income sources	0.01	0.02	0.005
Number of plots owned by household	0.13**	0.01	0.052
Livestock wealth (excluding poultry)	0.00	0.00	0.000
Household has pack animals (donkey/mule/horse/camel)	0.25***	0.03	0.097
Household has small livestock (sheep and goats)	0.41***	0.02	0.160
Poultry density (proportion of households in district that raise poultry)	1.68***	0.15	0.663
Rural location	-0.32*	0.18	-0.125
Household below hardcore poverty line	-0.07	0.06	-0.027
Interaction between poverty and rural location	0.39**	0.18	0.153
Region			
Tigray	0.48***	0.05	-
Afar	0.35***	0.06	-
Amahara	-0.03	0.04	-
Oromiya	-0.03	0.04	-
Somale	0.03	0.05	-
Benishangul	0.07	0.06	-
SNNPR	-0.19***	0.04	-
Harari	-0.07	0.06	-
Dire	-0.99***	0.09	-
Constant	-1.07***	0.12	-
No. of observations =15374			
Pseudo R2= 0.1053			

Source: HICE 2004–05.
Notes: *** Statistically significant at 1% level; ** statistically significant at 5% level.

Table A.2. ZINB Model: Determinants of household poultry-holding size

Variable	Coefficient	Std. Error	Marginal Effect
Poultry flock size			
Age of household head (years)	0.003	0.004	-0.0055
Age of household head squared (years)	0.000	0.000	0.0000
Household size	0.007	0.006	0.0150
Proportion of female adults (15 years and up)	-0.052	0.054	-0.2670
Proportion of children (below 18 years)	-0.020	0.056	-0.0420
Number of income sources	-0.026	0.023	-0.0556
Livestock wealth (excluding poultry)	0.000***	0.000	0.0001
Household has pack animals (donkey/mule/horse/camel)	0.103***	0.023	1.1226
Household has small livestock (sheep and goat)	-0.002	0.022	1.0714
Poultry density (proportion of households in district that raise poultry)	-0.032	0.137	4.3154
Rural location	0.034	0.194	-0.2174
Household below hardcore poverty line	0.009	0.055	0.0188
Interaction between poverty and rural	-0.167	0.194	-
Region			
Tigray	0.106**	0.044	-
Afar	0.120**	0.053	-
Amahara	-0.097**	0.040	-
Oromiya	-0.043	0.039	-
Somale	0.185***	0.051	-
Benishangul	-0.053	0.053	-
SNNPR	-0.034	0.042	-
Harari	-0.176***	0.067	-
Dire	-0.999***	0.111	-
Constant	1.329***	0.116	-
Inflate			
Age of household head (years)	0.013**	0.007	-
Age of household head squared (years)	0.000**	0.000	-
Proportion of female adults (15 years and up)	0.169**	0.089	-
Household has pack animals (donkey/mule/horse/camel)	-0.987***	0.056	-
Household has small livestock (sheep and goat)	-1.228***	0.047	-
Poultry density (proportion of households in wereda that raise poultry)	-4.758***	0.269	-
Rural location	0.316	0.321	-
Interaction between poverty and rural location	-0.517	0.322	-
Constant	2.430***	0.203	-
Lnalpha	-0.3843***	0.0331	
Alpha	0.6809***	0.0225	
Voung test statistic = 26.17 (Pr>z = 0.0000)			
No. of observations= 19044; No of Nonzero observations = 8900; No of Zero observations = 10144			

Source: HICE 2004–05.
Notes: ZINB is zero inflated negative binomial; *** statistically significant at 1% level; ** statistically significant at 5% level.

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