Activity Portfolios in Rural Ethiopia:

Choices and Constraints

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Peasant households, especially African rural households, can hold very diversified portfolios of economic activities. Portfolio diversification is often seen as a risk-reducing mechanism and linked with lowering risk at the cost of a lower income. A simple theoretical model of activity choice reveals that factors other than risk might influence the desire to diversify. In addition, binding entry-constraints might exist for certain off-farm activities. An empirical analysis of Ethiopian rural households suggests that entry-constraints are important in explaining portfolio and that diversification can actually result in increasing income.

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Introduction

In rural areas of developing countries a large share of the population consists of farmers engaged in subsistence farming, commercial farming, livestock rearing or a mixture of these. However, peasant households, especially African rural households, have highly diversified economic activities, many if them non-agricultural (Collier and Gunning). The nature of such activities is very diverse; both wage labor and small businesses appear. Contribution of non-agricultural employment in household income can be substantial and has been rising over the last decades.

The aim of this paper is to examine the activity portfolios of rural Ethiopian households and identify the underlying causes of portfolio diversification. In the literature much attention was paid to portfolio diversification as a risk reducing mechanism. Theory as well as empirical evidence has pointed to the importance of risk as a driving force of portfolio diversification. Theory suggests that risk-averse households are willing to trade average income for less variability in income and that they hence choose to earn income from several sources in order to stabilize the income stream, even if this lowers average income (Alderman and Paxson). Empirical studies from many countries have supported this view of diversification being linked to lowering risk at the cost of lower incomes. In Africa however, the poorest households seem to be less diversified despite the fact that they are more risk-averse (Collier and Gunning). Collier and Gunning attribute this to the fact that poorer households are more constrained from entering into off-farm employment because they lack the means to invest in capital-intensive activities. There might also be other constraints such as the need for higher education or special skills and limitations related to location (Dercon and Krishnan). A household willing to diversify then might not have the capacity to do so because of binding entry-constraints. To assess the importance of choices versus constraints in portfolio diversification we will analyze the factors influencing off-farm employment.

In former studies portfolio diversification was usually discussed on the basis of income shares. However, high off-farm income shares might indeed be an indication of an income diversification strategy but might as well reflect poor agricultural performance. To avoid this problem we will concentrate on labor allocation and deal with income in as far as they reflect the outcome of the activity portfolio. We begin with presenting the labor allocation problem in a formal model. This will result in additional theoretical insights, which can be linked with the existing empirical literature. Next, a descriptive analysis of the survey villages is given. A short section on the methodology of the statistical analysis follows. Further, the results of the estimations are discussed and interpreted and the findings are related to the theory. A last section concludes.

A Model of Activity Choice under Constraints

A theoretical analysis of the potential driving forces of portfolio diversification, based on a simple model of activity choice, can give useful insights and allows drawing some hypotheses. To construct the model, each household is assumed to have a plot of land[1] A and an amount of labor L which can be allocated to different activities. First, the household can be involved in agricultural production, characterized by a constant-return-to-scale production function f with land A, for which a market is assumed to be missing[2], and technology T, which depends on climatological and soil conditions, fixed factors of production and labor the variable factor of production. Labor can be provided by the household L_1 or can be hired in[3] L_r at a cost w and an with the need for supervision at an increasing rate $s(L_r)$. The marginal return to labor is assumed to be positive and decreasing, $f_L>0$ and $f_{LL}<0$, but increasing with land and technology, $f_{LA}>0$ and $f_{LT}>0$. In addition, it is assumed that for $A>0$, $lim_{L®0}\ f_L=¥$, such that all households will work there land with some labor. The return to agricultural production at time t, given by $P_{t1}f(L_{t1}+L_{tr},A_t,T_t)-w_tL_{tr}$, is variable due to climatological, soil-concerning and biological factors that influence the adopted technology T_t as well as economic factors such as changes in agricultural prices P_t. Second, the household can allocate labor L_n to specific off-farm activities with different return $P_{tn}g(L_{tn}|S_n)$ and entry-constraints S_n, which are e.g. the need for special skills or capital for investment. Also, some liquid assets Y_t that yield a return r can be held. The household is assumed to be risk-averse and will maximize expected intertemporal utility V with instantaneous utility v, a concave function of consumption c at time t, and discounted at a rate d.

$$\max V_t = E\sum_{t=t}^{T}(1+d)^{t-1}v(c_t);t=0,1,2,3,....,T \qquad (1)$$

This maximization problem is subject to several constraints: a budget constraint, a time constraint and some non-negativity constraints (appendix p20). In addition, a borrowing constraint results from the assumption of missing credit markets[4]. Solving the maximization problem with dynamic programming (appendix p20-21), the standard condition for optimal consumption with borrowing constraints and concavity (equation 2) and the standard portfolio choice model (equation 3 and 4) are obtained.

$$v'(c_t) = \frac{1+r}{1+\delta} EV'(c_{t+1}) + \mu_t \qquad (2)$$

$$E(v'(c_t)P_{tn}\frac{\partial g_{tn}}{\partial L_{tn}}) = E(v'(c_t)P_{t1}\frac{\partial f}{\partial L_{t1}}) = \eta_t \quad \text{with } L_{t1} > 0 \text{ and } L_{tn} > 0 \qquad (3)$$

$$E(v'(c_t)P_{tn}\frac{\partial g_{tn}}{\partial L_{tn}}) < E(v'(c_t)P_{t1}\frac{\partial f}{\partial L_{t1}}) = \eta_t \quad \text{with } L_{t1} > 0 \text{ and } L_{tn} = 0 \qquad (4)$$

If the borrowing constraint is not binding (μ_t=0 in equation 2) consumption decisions will be made such that the marginal utility of consumption today equals the present discounted value of expected marginal utility the future. The household is able to smooth consumption ex-post[5]: the negative effects of income shocks are spread intertemporally through selling and accumulating liquid assets or through borrowing and lending. In general richer households will have a larger ability to smooth consumption ex-post because they are more likely to have assets to sell and have a better access to credit, e.g. because they can provide collateral for a loan (Eswaran and Kotwall). If neither borrowing nor selling assets is an option, a risk-averse household will consume less today in order to be able to consume enough in the future.

The results of the labor allocation problem indicate that a household might, in stead of specializing into agriculture (equation 4), take up other activities and equalize expected marginal utilities (equation 3). Possible motivations to do so and underlying influencing factors can be analyzed on the basis of the model. First, a more risk-averse household, with a more concave utility function *v*, will have a lower expected marginal utility from agricultural production and will sooner take up other activities, even if this lowers average income. It is generally assumed that the degree of risk-aversion is a declining function of income (Mas Collel et al). In addition, the poor might seem more risk-averse, even if they have the same preferences towards risk, because they have less ability to smooth consumption ex-post (Eswaran and Kotwall). So, the poor who are more risk-averse, have less access to credit and a worse assets position would desire a more diversified portfolio in order to reduce the variability in income ex-ante (Alderman and Paxson). Second, the risk associated with agricultural production reduces expected marginal utility and will result in more diversification, especially in marginal areas that are more prone to drought, soil degradation, plagues etc. Third, a low opportunity cost of labor, caused by a low marginal return to labor in agriculture, will drive people towards diversification. The seasonal character of agriculture in the tropics[6] causes the opportunity cost of labor to be lower during off-season. Further, in less favorable areas the opportunity cost is lower because poor soils and low rainfall place technical limits to cropping options. Also, a lower land-to-man ratio lowers the opportunity cost of labor. Fourth, particular off-farm activities might offer a high return to labor such that households could increase average income by diversifying the portfolio. So, households might wish to hold a diversified portfolio of activities as insurance against risk, to increase average income or to reallocate labor endowments given land endowments and the available technology. Yet, a household willing to diversify might not always have the opportunity to do so. If the requirement S_n cannot be met, entry into off-farm activities is impossible and the household will specialize into agriculture, even if a more diversified portfolio is wanted. Also, the marginal return to labor in non-agricultural activities might be so low that households are not willing to take them up in the portfolio.

On the one hand, behavior towards risk predicts more portfolio diversification among poorer households and in less favorable areas. In addition, households with less land and more labor endowments and households facing a poorer agricultural technology due to seasonality or unfavorable conditions will diversify more. On the other hand, poorer households might be more constrained to enter into off-farm activities because they lack the necessary skills or the capital to invest. A larger capacity to diversify exists in favorable areas because a general higher level of income makes entry-constraints easier to overcome and because farm-nonfarm linkages can increase the profitability of off-farm activities. A good infrastructure can also increase the return to and facilitate entry into non-farm activities e.g. due to lower transportation cost and a better marketing of products.

Theory is not really unambiguous on how factors specific to households, villages and agro-ecological zones will influence portfolio diversification. Neither have empirical studies been able to clarify things. Reardon, Delgado and Malton e.g. find more portfolio diversification in the agro-ecologically best and poorest zones in comparison with the intermediate zones of Burkina Faso. Some studies point to evidence of a larger share of non-cropping income among wealthier households while others find non-farm earnings to be more important among the poor[7] (Haggblade et al). These apparent contradictions in results could be due to the aggregation of different kinds of income sources[8]. In this study we look at labor allocation to separate groups of activities. We argue that poorer households are involved in other activities, with less entry-constraints. Similar, we expect activity portfolios to have a different nature across regions with different cropping condition and villages with a different degree of infrastructure. In this respect, Reardon, Delgado and Matlon conclude that diversification can spring from both a situation of poverty, stagnation, and instability as well as from a dynamic agricultural base but they do not relate this finding to different activity portfolios.

Data and Descriptive Analysis

The data used for empirical analysis come from the Ethiopian Rural Household Survey, ERHS. This is a panel survey of 3 rounds covering 1477 households in 15 villages, selected to account for the diversity in agro-climatological conditions. The study, conducted by the Center for the Study of African Economies, Oxford in corporation with the Economic Department of Addis Ababa University, started in the first half of 1994, continued with a second round later in the same year and concluded wit a third round in the beginning of 1995. The timing of the three rounds allows us to disentangle the seasonal effects in portfolio diversification and other effects related to risk and entry-constraints[9].

Before turning to a statistical analysis of portfolio diversification, some general household and village characteristics are discussed. The welfare level of the households varies across the sample but is in general very low. With an equivalent of US $15 monthly per capita expenditure is on average below the absolute poverty line of US $1 a day[10]. This low level of welfare could imply that risk considerations are important here. Education is also very poor throughout the sample and is decreasing with wealth position. Male household-heads have on average had a schooling of 1.76 years, their female counterparts only 0.64. Consequently, women might be more constrained to enter into certain activities while higher educated people might have clear comparative advantages since they are not very numerous.

Ethiopia is predominantly an agrarian economy[11] and that is revealed by the data (table 1). Nearly all households in the sample are cultivating some land but the size of the landholdings and the kind of crops grown, varies across the survey sites. Farm size is smaller in areas with a high potential for agricultural cultivation. This might be due to a higher population pressure in those areas. In less favorable areas farmers concentrate on growing food-crops, mostly cereals, while in higher potential areas also perennials and cash-crops such as coffee and enset are grown.

Table 1: Agricultural Practice in Surveyed Villages

Survey site	agricultural potential*	% of households involved in cropping	average farm size (ha)**	main crops grown	% of households owning livestock	average value of livestock
Haresaw	low	98%	0.51	cereals	54%	479
Geblen	low	95%	0.25	cereals	76%	828
Dinki	middle/high	82%	1.63	sorghum, tef	64%	817
Debre Bernhan	low	98%	5.06	cereals	98%	4880
Yetemen	middle/high	92%	1.55	cereals	82%	2399
Shumsha	low	89%	2.52	cereals	79%	1215
Sirbana Godeti	middle	87%	2.03	cereals, tef	80%	3019
Adele Keke	middle	93%	1.28	sorghum, maize, chat	78%	1003
Korodegaga	low	99%	3.66	maize, teff	96%	1931
Trirufe Ketchema	middle/high	99%	1.10	cereals, coffee, enset, chat	79%	1681
Imdibir	high	100%	0.14	enset, tef, coffee, chat	84%	1011
Aze Deboa	middle/high	99%	0.76	cereals, enset, tef, coffee	93%	1364
Adado	high	98%	0.59	enset, maize, tef, coffee	45%	262
Gara Godo	high	99%	0.80	enset, coffee, tef	77%	458
Domaa	middle/high	95%	1.91	maize, tef, sweet potatoes	54%	732

Source: calculated from survey data and village studies

* A categorical indicator of the agricultural potential of the villages was constructed using village level information on agro-ecological zoning and altitude, rainfall, soil quality and duration of the wet season (appendix p22).

** The average farm size includes owned land as well as leased and rented land.

The percentage of households owning some livestock, mainly cattle, varies from 50% to almost 100% across the villages, reflecting the importance of mixed farming in Ethiopia, especially in the highlands. The use of cattle as traction power is crucial in agricultural cultivation. Livestock also contributes to the food supply, provides manure and is used as a means of transport. In addition, livestock is a relatively liquid asset that could be used for consumption smoothing. Some evidence of this was found in the data by looking at the timing of selling livestock. The income from the sale of animals is up to 50% higher in non-post-harvest periods compared to post-harvest periods and this percentage decreases with wealth. This could indicate that selling livestock is a means to compensate for harvest shortfalls and that hence livestock holdings could be inversely related to the need for diversifying the portfolio.

Next to being (mixed-) farmers, Ethiopian rural households are involved in a whole range of other activities. To facilitate analysis the different activities were grouped according to the type and content of the work (table 2). Agricultural wage employment is wage labor on someone else's land but does not include traditional labor sharing. Non-agricultural activities can be split up in wage employment and self-employment. Non-farm wage labor can be unskilled or skilled or could consist of employment in food-for-work programs[12]. Self-employed people can be involved in firewood collection, crafts or trade. The first includes the gathering itself as well as preparing and selling firewood, dungcake and charcoal for fuel. Self-employment in crafts includes weaving, spinning, hairdressing, cigarette making, handicrafts, etc. Activities related to marketing of products, including transport, form a last group.

Table2: % of Households Involved in Different Activities across the Surveyed Villages

Survey site	agricultural wage employment	non-farm wage-employment: food-for-work	non-farm wage-employment: unksilled labor	non-farm wage-employment: skilled labor	non-farm self-employment: firewood collection	non-farm self-employment: crafts	non-farm self-employment: trade	off-farm employment
Haresaw	1	73	0	2	0	2	6	77
Geblen	0	77	3	3	3	2	0	82
Dinki	17	1	8	1	0	70	3	52
Debre Bernhan	7	0	6	6	15	7	12	48
Yetemen	3	0	3	3	5	21	30	43
Shumsha	12	2	19	7	8	5	7	42
Sirbana Godeti	13	0	13	4	1	16	6	55
Adele Keke	26	22	19	6	1	10	13	58
Korodegaga	13	2	7	4	47	5	10	58
Trirufe Ketchema	19	14	22	11	0	10	20	97
Imdibir	34	72	12	9	7	57	51	64
Aze Deboa	7	0	11	17	0	19	44	82
Adado	41	0	15	6	0	20	59	98
Gara Godo	13	89	15	11	0	14	56	66
Domaa	14	0	8	12	0	27	27	44

Source: calculated from survey data

The percentages of households involved in those activities (table 2) suggest that some activities are very location specific, e.g. firewood collection appears only in 6 of the 15 villages. Activities as trade, skilled and unskilled wage employment seem to be more important in agriculturally better areas. Portfolio diversification is unambiguously an important issue in rural Ethiopia: 68% of the sampled households take up at least one non-agricultural activity in their portfolio.

Methodology

On the basis of a model of activity choice it was possible to identify some factors that could influence portfolio diversification. It was argued however that the same factor could have opposite effects, which could be related to the kind of activities that are included in the portfolio. To further investigate this empirically we will regress the percentage of time[13] spent on the different groups of activities, identified above, upon a set of relative factors. According to the model, the household's labor and land endowments, the level of education, the asset position and the access to credit might influence portfolio diversification. To capture these effects we include the following independent variables: the number of children, female and male adults[14] and elderly persons; the age of the household head; a dummy for female headed households; the highest level of education[15] in the household; the value of consumer durables, productive assets and livestock; the size of cultivated land; the size of owned land and a dummy for being a member of a credit organization (an *equb*). In addition, a dummy for the stage of the agricultural season (indicating whether the period is a peak labor time period in agricultural) is included to capture seasonal effects. The model also predicts an impact of the agricultural potential and the infrastructure of the area. To allow for this, we include village fixed effects in a first set of regression. These dummies also account for differences in prices and other unobserved village specific characteristics. In a second set of regression we include a categorical variable indicating the agricultural potential of the village (table 1 and table i, appendix) and a numerical variable for the accessibility[16] of the village with respect to towns and markets.

The dependent variable, the percentage of time spent on an off-farm activity, is a continuos variable but the range is limited from 0 to 100. In addition, there is a large proportion of cases where the dependent variable is 0, meaning that the household is not involved in the activity. Tobit models are particularly suited to model this type of endogenous variables that have a continuous distribution but with a probability mass at one discrete point (Amemiya). We will estimate 14 tobit regression for the 7 groups of activities and with the 2 different equation specifications.

Results

The results of the tobit regressions are given in the appendix (table ii and table iii). Each group of activities will be discussed separately. Some general interpretations are given and an association of the results with the theory is given.

Agricultural wage employment

The villages fixed effects on agricultural wage labor are very diverse. First, a higher agricultural potential has a positive effect because of a higher demand for agricultural wage labor. Second, beliefs and traditions play a role. In some high potential villages (Aze Deboa, Gara Godo and Domaa) agricultural wage employment is low because people have but a poor opinion of working on someone else's land for pay. The emerging positive effect of accessibility could be related to this: traditions might be stronger in more isolated villages. At the household level, lower educated farmers owning less land, livestock and other productive assets but having more male labor endowments have a higher probability to be engaged in agricultural wage employment while female headed households are disadvantaged. Further, the positive effect of the peak labor time dummy simply means that the demand for agricultural wage labor is higher during the agricultural season.

Non-farm wage employment: food-for-work programs

Only a few of the surveyed villages are accommodated with food-for-work programs. Accordingly, employment in such programs is very location specific and not much influenced by household characteristics. In our sample it seems that these projects are targeted towards poorer and more densely populated areas where non-land asset holdings are smaller and family sizes larger. There is however no indication of targeting towards the poor within the villages. Not much can further be revealed from the regressions; the only important issue for working in return for food is weather or not there is a program.

Non-farm unskilled wage employment

Not many significant effects were found for unskilled wage labor. Elderly and female-headed households seem to be excluded from such activities. *Equb* membership and livestock holdings have a positive respectively a negative effect. The first could mean a higher capacity to enter wage employment through a more extended social capital network. At the village level, accessibility has a positive effect, which is related to the fact that 33% of the unskilled laborers are employed outside the own village.

Non-farm skilled wage employment

Entry into non-farm skilled wage employment is constrained by the need for a higher education. Wealthier, in the form of more non-productive assets, and more educated households have a higher probability of having a professional among its members. There are no further household or location specific significant effects. The need for a higher education is however a very binding constraint because of a general very low level of schooling.

Non-farm self-employment: firewood collection

Gathering, preparing and selling firewood, charcoal or straw is a group of activities that is again very location specific. Significantly positive fixed effects appear for only 2 survey-sites, Korodegaga and Debre Bernhan. These are agro-ecologically less favorable regions where farm-sizes and cattle herds are large (table 1). In those land abundant areas there are probably more trees and bushes, which makes collection of firewood more profitable. In this way a better accessibility (proximity to demand centers) also encourages firewood collection. The village fixed effect regression further reveals that there are no particular labor or capital requirements associated with firewood collection; involvement is a little biased towards less educated households with a worse asset position. In addition, the positive effects of the peak labor time dummy indicate that it is a slack season activity.

Non-farm self-employment: crafts

Self-employment in weaving, spinning, milling, etc is more attractive to older households with more female labor time (more female adults and less children), a lower education, more non-land productive assets and smaller livestock holdings. Besides, membership of an *equb* is significantly positive. This could indicate that entry into these small businesses requires some capital. Other possible constraints are related to location: a higher agricultural potential and a better accessibility increase employment in crafts. This is probably related with a higher profitability due to farm-nonfarm linkages and a better marketing of handmade products. As in the case of firewood collection, involvement in crafts also varies contra-cyclical with the agricultural season.

Non-farm self-employment: trade

Participation in commerce is biased towards males with a higher education. Membership of an *equb* works positive on the probability to be a trader, which might reflect the need for capital to build up a stock of merchandise, a higher social capital or an insurance mechanism before entering into some risky business. Mostly it concerns trade in grain and cash crops, except for the village Debre Bernhan where trade in livestock and livestock products is more important. That is why trade employs more people in agro-ecologically favorable areas, during the agricultural season. Also, a better accessibility enlarges the scope for engaging in trade.

The results of the regressions suggest that entry into most off-farm activities be constrained in some way. The most severely constrained groups of activities are skilled wage employment and trade. For both a higher education is needed but in the case of skilled wage labor this constraint is more binding. In addition, trade might require some capital or credit, male labor endowments, a good agriculture and an extended infrastructure. Employment in these activities is not determined by the household's choice but rather by it's ability to overcome the constraints. Yet, a household chooses to engage in self-employment, crafts and firewood collection, during off-season because the opportunity cost of labor is lower then. They also choose to allocate labor to off-farm employment if they have less land endowments and other productive assets. The choice to engage in agricultural wage labor or crafts can also reflect a strategy to reduce risk for households with less livestock to sell for consumption smoothing. There are however also constraints associated with these activities. Opportunities for agricultural wage labor and small businesses are restricted to areas with a growing agricultural sector while self-employment in crafts and firewood collection requires a good infrastructure for marketing of products.

The Outcome of Different Portfolios

Up till now we concentrated on labor allocation and discussed how a combination of choices and constraints will determine the kind of activities in the portfolio. In order to complete the analysis we need to inquire into the outcome of different portfolios. We do not intend to give a detailed analysis of the impact of portfolio diversification on welfare and confine ourselves to a description of the return to different activities and a comparison of incomes from different portfolios.

The measures of the rate of return to the different groups of activities in table 3 reveal that the gains from agricultural wage labor, food-for-work and crafts are similar and rather low. Returns to unskilled wage labor and firewood collection are a little higher and of the same magnitude. For the other two groups there is a wide dispersion[17] but it is clear that skilled wage labor has the highest return. Trade can yield a return that is as low as that of agricultural wage labor but is mostly higher. It appears that the activities with the most severe entry-constraints are those with the highest return.

Table 3: Central Tendency and Dispersion Measures for the Return to Different Activities

return to: (Birr/day)	mean	median	mode	standard deviation	range
agricultural wage employment	3.65	3	2	2.1	9
non-farm wage employment					
food-for-work	3.29	3.19	3.75	1.43	5.66
unskilled	4.2	3.66	5	2.8	17.59
skilled	9.23	7.14	5	7.05	37.55
non-farm self-employment					
crafts	3.46	2	2	3.82	19.67
trade	6.42	4	2	6.96	39.42
firewood collection	4.88	4.27	4	3.28	15.8

Source: calculated from survey data

Based on the percentage of time spent on different activities and using cluster analysis, households were divided into 10 portfolio groups (table iv, appendix) and per capita income was compared across these groups (table 4 and table v, appendix). A first group consists of households specializing in cropping. The second and third groups are mixed farmers who spent a little bit of their time on one respectively several off-farm activities. Their income is significantly lower than that of the first group. The fourth group of households spends on average 20% of their time on agricultural wage labor and has an income that lies between that of the mixed farmers and the cropping specialists. Group 5 are those working in food-for-work programs. Their income is very low which reflects again that these programs are well targeted. The fifth and sixth group include unskilled respectively skilled wage laborers. The latter have the highest income while the former are somewhere in the middle. The income of the craftsmen, group 8, is significantly lower than most other groups although the contribution to total household income is important. The ninth group consists of households involved in trade. Per capita income is not significantly lower than that of skilled wage laborers. The collectors of firewood, group 10, are also mixed farmers and are situated in the middle income classes.

Table 4: Income and Income Shares from Different Portfolios

cluster group	total income*	total per capita income**	income shares from cropping	livestock	off-farm employment	unearned income***
1	3105	698	74%	5%	0%	21%
2	2513	526	56%	23%	7%	14%
3	2859	486	55%	15%	20%	10%
4	3553	616	52%	1%	35%	12%
5	1323	281	43%	17%	33%	7%
6	3441	666	51%	2%	35%	12%
7	5250	862	42%	7%	46%	5%
8	2011	519	28%	2%	53%	17%
9	3072	705	47%	6%	43%	4%
10	2287	626	34%	22%	20%	24%

Source: calculated from survey data

*Yearly income in Birr.

**Yearly income in Birr per adult equivalent.

*** Unearned income includes remittance, gifts, transfers etc. but is mainly donations.

It is clear that portfolio diversification is not necessarily linked with a lower income and that hence risk is not very important as a driving force in portfolio diversification. Only for crafts some evidence is found of taking it up in the portfolio to lower risk at the cost of a lower income. Mostly diversification does not lower income and is driven by a low opportunity cost of labor in agriculture. However, some people might be willing to diversify the portfolio but do not have the capacity to do so because of entry-constraints. Diversification can also lead to substantial increases in income but entry into such activities is most severely constrained.

Conclusion

Theory suggests that differences in desire to diversify, driven by risk and opportunity costs of labor, and a differential capacity to enter into off-farm activities will cause portfolios among households to have a different nature and a different degree of diversification. In a sample of Ethiopian rural households the combination of desire and capacity to diversify was found to cause large differences in the constitution of activity portfolios. Households choose to diversify if the opportunity cost of labor is low, during off-season or in the case of small land endowments relative to labor endowments. The opportunities to do so are built on the base of a dynamic agriculture and a favorable location with respect to access to markets. The appearance of high-return activities in the portfolio is not determined by the households choice but by the ability to overcome entry-constraints and will result in higher incomes. Entry-constraints are more important in explaining portfolio diversification than factors related to risk.

[1] This assumption is quite realistic since Ethiopian households were all given a plot of land to cultivate after 1975 and in our sample of rural Ethiopian households almost all households are cultivating some land.

[2] Land rights in Ethiopia have, despite the land tenure reform, not yet evolved to the point at which land-scarce households could purchase land and leasing land is an option but not a common practice (Hansson).

[3] We assume there is a market for agricultural labor, which is plausible for the Ethiopian case since restrictions placed in 1974 on hiring agricultural labor have been eliminated in the reform of 1991.

[4] Credit markets in developing countries are usually absent are highly imperfect (Eswaran and Kotwall).

[5] Other possibilities to smooth consumption ex-post that are not captured by the model are risk-sharing across households and storing food for future consumption (Aldermand and paxson). However, the feasibility of these strategies is limited because of correlated risks in agriculture and food subject tot rotting, being inadequate to store (Dasgupta, 1993).

[6] Without access to irrigation water agriculture in the tropics is limited a short growing period during the rainy season.

[7] Reardon e.g. brought together data from several studies on diversification in different African countries. He calculated that, on average for those countries, the share of non-farm income in total income is two times higher in upper income terciles then in lower income terciles. He also points to the fact that in some studies on Asian countries the opposite effect was found.

[8] Reardon, Delgado and Malton aggregate all income sources other than cropping and analyze the share of non-cropping in total income. In a study on activity choice in Western Tanzania, Dercon distinguishes income from livestock and cropping but aggregates all other sources.

[9] The different rounds and the stage of the agricultural season do not coincide in the same way for all villages because the timing of the survey varies across the villages. Events in different stages of the agricultural season will be compared by constructing a parameter that indicates whether the investigated period is a peak labor time period in agriculture.

[10] To make this comparison an exchange rate of Birr 6.254 to US $ is used. The general low level of welfare is in line with the fact that 46% of the Ethiopian population lives under the poverty line (World Bank, 1999)

[11] 84% of the population is residing in rural areas and the primary sector constitutes 55% GDP and employs 86% of the labor force (World Bank, 1998).

[12] These are programs of the government or non-governmental organizations where people work on projects like the construction of a water reservoir, a soil conservation project, etc in return for food.

[13] The percentage of time is used because an absolute measure would bias the results towards households that have more time available or towards places where the survey covers a longer period. This percentage is calculated from the survey data as the number of days worked divided by the number of active household members multiplied with the number of days the survey covers. In this way sick or unable persons were excluded from contributing to the labor force while older children helping with farm or domestic work were included.

[14] We include male and female adults separately because they might have different comparative advantages.

[15] This is measured by the years of schooling.

[16] This is the distance from the nearest town multiplied by -0.5 if there is an all-weather road and by -1 if there is not.

[17] This wide dispersion could be due to aggregating different activities in one group: different professions in the group of skilled wage labor and e.g. trade in livestock and in grain in the group trade.

Appendix

A Model of Activity Choice under Constraints

Each household is assumed to have a plot of land *A* and an amount of labor *L* which can be allocated to different activities. First, the household can be involved in agricultural production, characterized by a constant-return-to-scale production function *f* with land *A*, for which a market is assumed to be missing, and technology *T*, which depends on climatological and soil conditions, fixed factors of production and labor the variable factor of production. Labor can be provided by the household L_1 or can be hired in L_r at a cost *w* and an with the need for supervision at an increasing rate $s(L_r)$. The marginal return to labor is assumed to be positive and decreasing, $f_L>0$ and $f_{LL}<0$, but increasing with land and technology, $f_{LA}>0$ and $f_{LT}>0$. In addition, it is assumed that for $A>0$, $lim_{L®0}\ f_L$=¥, such that all households will work there land with some labor. The return to agricultural production at time *t* is given by $P_{t1}f(L_{t1}+L_{tr},A_t,T_t)-w_tL_{tr}$. Second, the household can allocate labor L_n to specific off-farm activities with different return $P_{tn}g(L_{tn}|S_n)$ and entry-constraints S_n. Also, some liquid assets Y_t that yield a return *r* can be held. The household is assumed to be risk-averse and will maximize expected intertemporal utility V with instantaneous utility v, a concave function of consumption c at time t, and discounted at a rate δ.

$$\max V_t = E\sum_{t=t}^{T}(1+d)^{t-1}v(c_t); t = 0,1,2,3,....,T$$

This maximization problem is subject to the following constraints:

- a budget constraint
  $$c_t + Y_t = P_{t1}f\left(L_{t1} + L_{tr}, A_t, T_t\right) - wL_{tr} + \sum_n P_{tn}g\left(L_{tn} \mid S_n\right) + (1+r)Y_{t-1}$$
- a time constraint
  $$L_t \geq L_{t1} + s\left(L_{tr}\right) + \sum_n L_{tn}$$
- non-negativity constraints
  $$L_{t1} \geq 0$$
  $$L_{tn} \geq 0 : \forall n$$
- a borrowing constraint
  $$Y_t \geq 0$$

Derived from the objective function of the dynamic programming

$$\Psi = v(c_t) + \frac{1}{1+d}V_{t+1}(c_{t+1}) + m_tY_t + h_t(L - L_{t1} - \sum_n L_{tn} - s(L_{tr})) + q_tL_{t1} + \sum_n e_{tn}L_{tn} + s_tL_{tr}$$

with $$c_t = P_{t1}f(L_{t1} + L_{tr}, A_t, T_t) - wL_{tr} + \sum_n P_{tn}g\left(L_{tn} \mid S_n\right) + (1+r)Y_{t-1} - Y_t$$

the Kuhn-Tucker first order conditions are obtained:

$$\frac{\partial \Psi}{\partial c_t} = v'(c_t) - \mu_t - \frac{1+r}{1+\delta} EV'(c_{t+1}) \le 0; c_t \frac{\partial \Psi}{\partial c_t} = 0 \qquad \text{(I)}$$

$$\frac{\partial \Psi}{\partial L_{t1}} = E(v'(c_t) P_{t1} \frac{\partial f}{\partial L_{t1}}) - \eta_t + \theta_t \le 0; L_{t1} \frac{\partial \Psi}{\partial L_{t1}} = 0 \qquad \text{(II)}$$

$$\frac{\partial \Psi}{\partial L_{tn}} = E(v'(c_t) P_{tn} \frac{\partial g}{\partial Ln}) - \eta_t + \varepsilon_{tn} \le 0; L_{tn} \frac{\partial \Psi}{\partial L_{tn}} = 0 \qquad \text{(III)}$$

From equation (I) we obtain the standard condition for optimal consumption with borrowing constraints and concavity:

$$v'(c_t) = \frac{1+r}{1+\delta} EV'(c_{t+1}) + \mu_t$$

Equations (II) and (III) lead to two possible solutions. First, $L_{tn} = 0$, $\varepsilon_{tn} = 0$ and equation (III) will hold with inequality. $L_{t1} > 0$ and equation (II) holds with equality. The household specializes in agriculture:

$$E(v'(c_t) P_{t1} \frac{\partial f}{\partial L_{t1}}) > E(v'(c_t) P_{tn} \frac{\partial g}{\partial Ln}); L_{t1} > 0 \;\&\; L_{tn} = 0$$

Second, $L_{t1} > 0$ and $L_{tn} > 0$. Both equation (II) and (III) hold with equality. The household will equalize expected marginal utilities:

$$E(v'(c_t) P_{t1} \frac{\partial f}{\partial L_{t1}}) = E(v'(c_t) P_{tn} \frac{\partial g}{\partial Ln}) = \eta_t ; L_{t1} > 0 \;\&\; L_{tn} > 0$$

Specializing in off-farm activities not an option here because $lim_{L \to 0} f_L = \infty$ such that L_{t1} can never be zero.

Table i: The Agricultural Potential in Surveyed Villages

Survey site	altitude (meter)	agro-ecological zoning*	mean annual rainfall** (mm)	soil quality***	% of land cultivated during Meher and Belg****	agricultural potential
Haresaw	2597	dega	558	taf	8%	low
Geblen	2700	woyna dega	504	taf	3%	low
Dinki	1400	kolla	1664	lem-taf	30%	middle/high
Debre Bernhan	2714	dega	919	lem-taf	9%	low
Yetemen	2650	woyna dega	1241	lem	5%	middle/high
Shumsha	1750	kolla	654	taf	1%	low
Sirbana Godeti	1900	woyna dega	672	lem	0%	middle
Adele Keke	2000	woyna dega	748	lem-taf	39%	middle
Korodegaga	1000	kolla	874	taf	0%	low
Trirufe Ketchema	2000	woyna dega	812	lem	67%	middle/high
Imdibir	2000	woyna dega	2205	lem-taf	68%	high
Aze Deboa	2350	dega	1509	lem-taf	77%	middle/high
Adado	2000	woyna dega	1417	lem	66%	high
Gara Godo	1750	woyna dega	1245	lem	77%	high
Domaa	1000	kolla	1150	lem	28%	middle/high

Source: Ethiopian Village Studies

*dega = highlands; woyna dega = temperate zone; kolla = lowlands
**Average mm percipitation of the last 10 years in the nearest meteorological station
***Meher = rainy season from June till September; Belg = dry season from January till April

Table ii: Regression Results: Specification 1

	agricultural wage employment		non-farm wage-employment					
Independent variables			food-for-work		unskilled labor		skilled labor	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
# children	-0.000741	0.875	-0.001254	0.765	-0.004018	0.610	0.013785	0.084
# female adults	0.005762	0.534	0.004188	0.578	0.003926	0.793	-0.010388	0.480
# male adults	**0.030959**	0.000	0.006482	0.382	0.014812	0.300	-0.001789	0.902
# elderly persons	-0.008784	0.521	-0.012819	0.273	0.008245	0.713	-0.004688	0.846
age hh-head	0.003693	0.211	0.003738	0.134	**0.009802**	0.085	0.005540	0.351
(age hh-head)^2	-0.000049	0.095	-0.000033	0.188	**-0.000119**	0.043	-0.000059	0.329
female headed hh	**-0.081051**	0.001	-0.007175	0.700	**-0.100615**	0.008	-0.050804	0.228
education	**-0.011181**	0.000	**0.005175**	0.024	0.003210	0.442	**0.024686**	0.000
consumer durables	-0.000009	0.538	-0.000006	0.580	0.000008	0.226	**0.000016**	0.000
productive assets	**-0.000182**	0.051	-0.000054	0.236	-0.000124	0.258	0.000000	0.998
livestock holdings	**-0.000035**	0.000	-0.000004	0.572	**-0.000054**	0.000	-0.000015	0.093
cultivated land	**0.001617**	0.037	0.000415	0.805	-0.000166	0.958	-0.001759	0.772
owned land	**-0.001546**	0.062	-0.000116	0.946	-0.000360	0.911	0.001126	0.852
equb member	0.003938	0.868	-0.038235	0.112	**0.081522**	0.022	0.044560	0.212
peak labor time	0.033461	0.120	**0.390128**	0.000	0.016736	0.638	-0.036569	0.320
Haresaw	-0.254921	0.006	**0.784661**	0.000	-2.070872	.	-0.195757	0.056
Geblen	-1.299355	.	**0.705161**	0.000	**-0.338191**	0.002	-0.152543	0.169
Dinki	0.063917	0.102	-0.120557	0.168	**-0.289257**	0.000	-0.256731	0.054
Debre Bernhan	0.006418	0.889	-0.947547	.	-0.108719	0.079	0.011551	0.860
Yetemen	-0.002860	0.958	-1.061082	.	**-0.261492**	0.010	0.018880	0.819
Sirbana Godeti	0.063054	0.144	-0.964019	.	-0.014377	0.807	-0.099463	0.213
Adele Keke	**0.105208**	0.011	**0.522062**	0.000	-0.036563	0.544	-0.070507	0.374
Korodegaga	0.044850	0.263	-0.970170	.	**-0.140485**	0.022	-0.078117	0.303
Trirufe Ketchema	**0.182146**	0.000	**0.437272**	0.000	0.057270	0.354	-0.025443	0.718
Imdibir	**0.210684**	0.000	**0.409689**	0.000	**-0.203994**	0.006	-0.123915	0.131
Aze Deboa	-0.077759	0.174	-0.990894	.	**-0.213477**	0.004	-0.038560	0.592
Adado	**0.179696**	0.000	-1.021815	.	**-0.105075**	0.052	-0.071442	0.293
Gara Godo	-0.069232	0.132	**0.377890**	0.000	**-0.202324**	0.001	-0.032696	0.647
Domaa	0.019705	0.683	**0.621063**	0.000	**-0.305343**	0.000	-0.024084	0.752
Constant	-0.455110	0.000	-0.915881	0.000	-0.651679	0.000	-0.822476	0.000
Log likelihood	-672.14		-404.36		-433.90		-807.57	
Prob>chi2	0.00		0.00		0.00		0.00	
Pseudo R2	0.19		0.58		0.12		0.26	

Table iii: Regression Results: Specification 2

	agricultural wage employment		non-farm wage-employment					
Independent variables			food-for-work		unskilled labor		skilled labor	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
# children	0.000578	0.900	0.001350	0.759	-0.000033	0.997	0.0147267	0.056
# female adults	-0.001717	0.847	**0.024306**	0.002	0.001382	0.926	-0.0102715	0.476
# male adults	**0.032425**	0.000	0.013046	0.105	0.017252	0.229	-0.0037994	0.790
# elderly persons	-0.007116	0.600	**0.031443**	0.013	0.007073	0.752	-0.0054251	0.817
age hh-head	0.003955	0.181	**0.006013**	0.028	0.009345	0.096	0.0046164	0.421
(age hh-head)^2	**-0.000053**	0.077	**-0.000059**	0.032	**-0.000116**	0.048	-0.0000505	0.386
female headed hh	**-0.086042**	0.001	0.017855	0.372	**-0.096391**	0.010	-0.0578511	0.163
education	**-0.011004**	0.000	**0.009327**	0.000	0.004578	0.247	**0.0241423**	0.000
consumer durables	-0.000022	0.198	-0.000017	0.160	0.000009	0.145	**0.0000156**	0.000
productive assets	-0.000072	0.352	0.000054	0.238	-0.000067	0.514	-0.0000134	0.825
livestock	**-0.000039**	0.000	**-0.000061**	0.000	**-0.000053**	0.000	-8.79E-06	0.247
cultivated land	**0.001354**	0.093	0.000264	0.850	-0.000370	0.919	-0.0021495	0.754
owned land	**-0.001630**	0.058	0.000219	0.877	-0.000868	0.815	0.0016351	0.811
equb member	-0.000911	0.967	0.031793	0.144	**0.071082**	0.035	0.0484305	0.152
peak labor time	**0.049217**	0.004	**-0.068702**	0.000	0.032605	0.235	-0.0326847	0.261
agricultural potential	**0.039455**	0.000	0.013971	0.077	-0.023559	0.080	-0.0062014	0.681
accessibility	**0.010154**	0.000	**-0.009989**	0.000	**0.006586**	0.043	0.0027723	0.421
Constant	-0.445064	0.000	-0.642976	0.000	-0.711495	0.000	-0.8313062	0.000
Log likelihood	-843.10		-694.10		-441.52		-933.35	
Prob>chi2	0.00		0.00		0.00		0.00	
Pseudo R2	0.13		0.05		0.11		0.14	

Table ii: Regression Results: Specification 1 (continued)

Independent variables	firewood collection		non-farm self-employment crafts		trade	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
# children	-0.003065	0.511	-0.008767	0.102	-0.001835	0.607
# female adults	**-0.018361**	0.040	**0.021886**	0.026	0.007030	0.276
# male adults	0.006338	0.441	0.006685	0.473	**0.011979**	0.060
# elderly persons	0.004945	0.699	0.006021	0.704	-0.007849	0.478
age hh-head	0.002869	0.330	**0.011064**	0.002	0.000597	0.798
(age hh-head)^2	-0.000039	0.189	**-0.000103**	0.004	-0.000024	0.307
female headed hh	-0.019683	0.260	-0.032536	0.215	0.009660	0.609
education	**-0.003648**	0.095	**-0.005340**	0.068	**0.005339**	0.005
consumer durables	-0.000007	0.566	-0.000026	0.164	0.000000	0.911
productive assets	-0.000200	0.105	**0.000186**	0.000	0.000043	0.158
livestock holdings	0.000005	0.135	**-0.000029**	0.000	-0.000007	0.132
cultivated land	-0.000292	0.884	-0.001393	0.654	-0.001108	0.473
owned land	0.000759	0.708	0.001264	0.684	0.000971	0.531
equb member	0.002480	0.893	**0.089305**	0.000	**0.083627**	0.000
peak labor time	**-0.205320**	0.000	**-0.084731**	0.000	**0.034316**	0.036
Haresaw	-0.947522	.	**-0.234355**	0.010	0.012557	0.819
Geblen	**-0.232170**	0.001	-0.160090	0.056	-0.959485	.
Dinki	-0.947264	.	**0.480340**	0.000	-0.038508	0.498
Debre Bernhan	**0.273494**	0.000	0.093750	0.078	0.072599	0.079
Yetemen	-0.066260	0.190	**0.236238**	0.000	**0.266238**	0.000
Sirbana Godeti	0.011889	0.806	**0.206120**	0.000	-0.013923	0.780
Adele Keke	**-0.212915**	0.000	0.004793	0.933	**0.139361**	0.001
Korodegaga	**0.285763**	0.000	0.026526	0.645	0.053318	0.221
Trirufe Ketchema	-0.926891	.	0.077412	0.168	**0.210310**	0.000
Imdibir	0.056677	0.195	**0.421075**	0.000	**0.279863**	0.000
Aze Deboa	-0.914442	.	**0.122906**	0.035	**0.226155**	0.000
Adado	-0.930954	.	**0.188729**	0.000	**0.371022**	0.000
Gara Godo	-0.931519	.	0.013068	0.818	**0.289422**	0.000
Domaa	**-0.229126**	0.000	**0.133911**	0.016	**0.203765**	0.000
Constant	-0.238324	0.001	-0.777728	0.000	-0.500745	0.000
Log likelihood	-234.65		-724.89		-746.89	
Prob>chi2	0.00		0.00		0.00	
Pseudo R2	0.71		0.14		0.31	

Table iii: Regression Results: Specification 2 (continued)

Independent variables	firewood collection		non-farm self-employment crafts		trade	
	Coeff.	p-value	Coeff.	p-value	Coeff.	p-value
# children	-0.002117	0.646	**-0.0262504**	0.000	0.001836	0.600
# female adults	-0.006349	0.481	**0.0180095**	0.071	0.003282	0.607
# male adults	**0.020492**	0.013	0.0037565	0.702	0.010246	0.108
# elder persons	-0.023520	0.068	-0.0050711	0.759	-0.010632	0.335
age hh-head	0.001743	0.540	**0.0156146**	0.000	-0.000808	0.725
(age hh-head)^2	-0.000024	0.403	**-0.000148**	0.000	-0.000010	0.674
female headed hh	**-0.035775**	0.046	**-0.0571357**	0.038	0.009672	0.608
education	-0.003279	0.151	**-0.0124057**	0.000	**0.005830**	0.001
consumer durables	-0.000028	0.094	-0.0000287	0.126	-0.000002	0.579
productive assets	-0.000135	0.213	**0.0002205**	0.000	0.000031	0.315
livestock	**0.000010**	0.002	**-0.000018**	0.005	-0.000005	0.237
land	**0.000460**	0.025	-0.000788	0.681	-0.001076	0.483
owned land	0.001657	0.952	0.0004833	0.803	0.001006	0.514
equb member	**0.040785**	0.029	**0.1297481**	0.000	**0.080793**	0.000
peak labor time	**-0.115949**	0.000	-0.0108467	0.585	**0.037313**	0.006
agricultural potential	**-0.259246**	0.000	**0.0970983**	0.000	**0.102508**	0.000
accessibility	**0.030087**	0.000	**0.0065849**	0.005	**0.002659**	0.094
Constant	0.324482	0.000	-0.9466851	0.000	-0.561208	0.000
Log likelihood	-431.54		-428.17		-795.82	
Prob>chi2	0.00		0.00		0.00	
Pseudo R2	0.47		0.48		0.26	

Table iv: Average % of Time Spent on Off-farm Activities for Different Portfolio Groups

cluster group	off-farm employment	non-farm wage employment			non-farm self-employment		
		food-for-work	unskilled labor	skilled labor	crafts	trade	firewood collection
1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2	0.1	0.4	0.2	0.1	0.4	0.5	0.5
3	0.6	0.8	1.0	0.5	1.0	1.6	0.3
4	19.8	0.2	0.9	0.0	0.6	1.8	0.5
5	0.3	11.1	0.3	0.2	0.5	1.3	0.0
6	0.8	0.4	21.7	1.3	0.8	1.6	0.9
7	0.3	0.9	1.1	19.5	0.9	1.9	0.0
8	0.7	0.7	0.9	0.6	21.7	1.2	0.2
9	1.6	0.6	0.9	0.3	0.3	19.3	0.1
10	0.3	0.1	0.5	0.1	0.1	1.2	11.2

Source: calculated from survey data

Table v: Results of ttest for Comparison of Per Capita Income across Portfolio of Groups

group	hypotheses	cluster group (a) 1	2	3	4	5	6	7	8	9
2	t-statistic	3.9701								
	P < t (Ha:mean(a)-mean(2)<0)	1.0000								
	P > |t| (Ha:mean(a)-mean(2)~=0)	0.0001								
	P > t (Ha:mean(a)-mean(2)>0)	**0.0000**								
3	t-statistic	4.2535	1.1217							
	P < t (Ha:mean(a)-mean(3)<0)	1.0000	0.8688							
	P > |t| (Ha:mean(a)-mean(3)~=0)	0.0000	0.2624							
	P > t (Ha:mean(a)-mean(3)>0)	**0.0000**	0.1312							
4	t-statistic	0.7191	-1.1767	-1.6824						
	P < t (Ha:mean(a)-mean(4)<0)	0.7638	0.1200	**0.0467**						
	P > |t| (Ha:mean(a)-mean(4)~=0)	0.4725	0.2399	0.0935						
	P > t (Ha:mean(a)-mean(4)>0)	0.2362	0.8800	0.9533						
5	t-statistic	6.2383	5.3894	4.3824	4.0290					
	P < t (Ha:mean(a)-mean(5)<0)	1.0000	1.0000	1.0000	1.0000					
	P > |t| (Ha:mean(a)-mean(5)~=0)	0.0000	0.0000	0.0000	0.0001					
	P > t (Ha:mean(a)-mean(5)>0)	**0.0000**	**0.0000**	**0.0000**	**0.0000**					
6	t-statistic	0.2151	-1.4810	-1.9502	-0.3885	-4.2680				
	P < t (Ha:mean(a)-mean(6)<0)	0.5851	**0.0697**	**0.0260**	0.3495	**0.0000**				
	P > |t| (Ha:mean(a)-mean(6)~=0)	0.8298	0.1393	0.0521	0.6989	0.0000				
	P > t (Ha:mean(a)-mean(6)>0)	0.4149	0.9303	0.9740	0.6505	1.0000				
7	t-statistic	-0.9667	-2.9949	-3.3685	-1.4161	-5.0334	-1.2429			
	P < t (Ha:mean(a)-mean(7)<0)	0.1672	**0.0015**	**0.0004**	**0.0809**	**0.0000**	0.1104			
	P > |t| (Ha:mean(a)-mean(7)~=0)	0.3343	0.0029	0.0009	0.1618	0.0000	0.2208			
	P > t (Ha:mean(a)-mean(7)>0)	0.8328	0.9985	0.9996	0.9191	1.0000	0.8896			
8	t-statistic	1.7970	0.1127	-0.4766	0.8422	-3.2049	1.2396	2.1842		
	P < t (Ha:mean(a)-mean(8)<0)	0.9635	0.5449	0.3170	0.7992	**0.0008**	0.8907	0.9840		
	P > |t| (Ha:mean(a)-mean(8)~=0)	0.0731	0.9103	0.6340	0.4017	0.0016	0.2187	0.0321		
	P > t (Ha:mean(a)-mean(8)>0)	**0.0365**	0.4551	0.6830	0.2008	0.9992	0.1093	**0.0160**		
9	t-statistic	-0.0668	-2.2269	-2.6151	-0.5787	-4.3977	-0.2248	0.7163	-1.3572	
	P < t (Ha:mean(a)-mean(9)<0)	0.4734	**0.0132**	**0.0047**	0.2822	**0.0000**	0.4114	0.7617	**0.0889**	
	P > |t| (Ha:mean(a)-mean(9)~=0)	0.9468	0.0264	0.0093	0.5643	0.0000	0.8228	0.4765	0.1777	
	P > t (Ha:mean(a)-mean(9)>0)	0.5266	0.9868	0.9953	0.7178	1.0000	0.5886	0.2383	0.9111	
10	t-statistic	0.5440	-1.1550	-1.6234	-0.0773	-3.8618	0.3260	1.3393	-0.8830	0.4687
	P < t (Ha:mean(a)-mean(10)<0)	0.7066	0.1244	0.0528	0.4693	**0.0001**	0.6272	0.9067	0.1898	0.6797
	P > |t| (Ha:mean(a)-mean(10)~=0)	0.5868	0.2487	0.1055	0.9386	0.0002	0.7457	0.1867	0.3796	0.6406
	P > t (Ha:mean(a)-mean(10)>0)	0.2934	0.8756	0.9472	0.5307	0.9999	0.3728	**0.0933**	0.8102	0.3203

Source: calculated from survey data

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