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Assets, activities and income generation in rural Mexico: factoring in social and public capital☆

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Abstract

In recent years, there has been increasing emphasis in the rural development literature on the multiple income-generating activities undertaken by rural households and the importance of assets in determining the capacity to undertake these activities. Controlling for the endogeneity of activity choice and applying Lee's generalisation of Amemiya's two-step estimator to a simultaneous equation model, household returns to assets from multiple activities are explored for the Mexico ejido sector. To incorporate the multiple variables representing social and public capital into the analysis, factor analysis is used. The results indicate that the asset position of the household has a significant effect on household participation in income-generating activities and returns to those activities. Furthermore, the inclusion of measures of social and public capital into the analysis show that these assets play an important role in income-generating activities and that the influence is dependent on the type of social and public capital as well as the particular activity.

JEL classification: O12; O13

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1. Introduction

In recent years, there has been increasing emphasis within the rural development literature on what is referred to as rural livelihoods and livelihood diversification. A key feature of the concept of livelihoods is the link between assets, activities and income and the role of the institutional context in determining the use of and returns to assets. For example, Ellis (2000) defines a livelihood as comprising "the assets (natural, physical, human, financial and social capital), the activities and the access to these (mediated by institutions and social relations) that together determine the living gained by an individual or household". Livelihood diversification is then the process by which households construct a diverse portfolio of activities and assets to survive and improve their standard of living (Ellis, 2000).

The livelihoods approach has played an important role in highlighting the multiple activities undertaken

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by rural households, the importance of assets in determining the capacity to undertake activities, the dynamic nature of the actions of rural households and the link between the diversification of assets and activities (Barrett and Reardon, 2000). Evidence from developing countries indicates that rural households rely on a number of assets and employ multiple activities to generate income. In particular, there has been strong evidence indicating the increasing importance of rural non-farm activities. Reardon et al. (2001), for example, show that, based on a set of studies from Latin America, rural non-farm activities make up 40% of rural household income. Furthermore, the trend is toward greater non-farm activities for rural inhabitants.

While the livelihoods approach has contributed to our understanding of rural household behaviour, there has been little empirical examination of the approach. A number of recent studies have recognised the role of a diverse set of assets in income-generating activities. For example, Lanjouw (1999, 2001) examines non-farm income in Ecuador and El Salvador using assets such as human capital (education, literacy), natural capital (land) and public capital (electrification, water connection) as explanatory variables. Winters et al. (2001) explore the role of assets, including social and public capital, in the decision to migrate. Corral and Reardon (2001), and De Janvry and Sadoulet (2001) explore the importance of natural, human, social and public capital in the generation of income in Nicaragua and Mexico, respectively. While recognising the importance of assets in income-generating activities, these studies do not consider both the simultaneous nature of asset allocation and the selectivity bias created by the decision to participate in an activity.

One recent study that does consider these issues is by Taylor and Yunez-Naude (2000). Their paper focuses on the returns to schooling from a diverse set of activities in rural Mexico broadening consideration to both household head and family schooling. Taylor and Yunez-Naude's paper is interesting from an econometric point of view in that they carefully address issues affecting bias and inefficiency in parameter estimates. By controlling for endogeneity of activity choice and using Lee's generalisation of Amemiya's two-step estimator in a simultaneous-equation model, the resulting estimators are asymptotically more efficient than other two-stage estimators, such as the commonly used Heckman procedure.

In this study, we use the same econometric approach as Taylor and Yunez-Naude to explore livelihood strategies in the Mexican ejido sector. Unlike Taylor and Yunez-Naude, our main interest lies in exploring the importance of community level factors, particularly social and public capital variables, in the participation in and returns to income-generating activities. Empirical evidence suggests that along with other forms of capital, social and public capital play an important role in household income-generation. For example, an analysis of Tanzanian households shows that higher levels of social capital are associated with greater levels of expenditure (Narayan and Pritchett, 1999). Understanding the role of social and public capital in income generation has important policy implications for governments. If governments decide to invest resources into alleviating poverty, it is essential to know how social and public capital influence income generation. Incorporating social capital and community level variables representing public capital into the analysis of assets and activities has proved problematic since these assets are generally difficult to measure in a way that truly represents the specific attributes of these assets and reflects how households secure benefits from them. We address this issue by using factor analysis to identify specific factors to represent social and public capital.

The remainder of this paper is divided into four sections. Section 2 provides a conceptual background for the relationship between assets, activities and income and discusses the empirical strategy for examining the use of assets in income-generating activities. Section 3 uses the Mexico data to define the set of assets rural Mexican household use for generating income. Participation in activities and returns to assets are examined using the Taylor and Yunez-Naude (2000) empirical approach. In Section 4, the issue of measuring and including social and public capital is addressed. Measures of these assets, calculated using factor analysis, are then included in the activity equations. Finally, in Section 5 conclusions are discussed.

2. Rural livelihood strategies: conceptual framework and empirical approach

The basis of a livelihood strategy is the asset position of the household at a given point in time. Note

that, as has become standard practice, household assets are defined broadly to include natural, physical, human, financial, public, household and social capital.[1] These assets are stocks, which may depreciate over time or may be expanded through investment. Based on access to a particular set of assets for a given period, the household must decide which activities it will employ and the intensity of involvement in that activity. For purposes of this paper, activities are actions taken by the household to produce income. They involve the use of a single asset or a set of assets. Agricultural production, for example, may use natural capital in the form of land and water, human capital, physical capital such as tractors, financial capital for the purchase of inputs and social capital in the form of labour assistance by community members. Alternatively, non-farm wage employment may only use human capital. The intensity of an activity depends on the degree to which assets are used. A strategy of agricultural intensification is likely to involve a greater use of human capital and financial capital (for the purchase of inputs) than a strategy that focuses on other activities or in less intensive agricultural production. The decision on the set of activities a household will employ and the intensity of those activities is conditioned on the context in which the household operates. The context influences household decisions through natural forces, markets, state activity and societal institutions.

Conceptually, the mapping of assets to income through activities can be viewed as similar to a production process, with assets corresponding to factors of production and income as the output of the process (Barrett and Reardon, 2000). The return to assets depends on the parameters of the functions, which are determined by prices of inputs and outputs as well as other characteristics of the context. The allocation of assets to each activity is expected to maximise household income subject to a number of constraints. Households will allocate assets in a manner that equates the marginal value product across activities or will allocate assets entirely to one activity that has a superior return.

One of the key features of this approach is that households simultaneously determine the allocation of assets to different activities. Failure to consider the simultaneous nature of the decision can lead to curious and often contradictory results across different studies. For example, Taylor and Yunez-Naude (2000) note that research on the returns to schooling in rural economies range from high to negative. They argue that the reason for this is that researchers have failed to take into account the technological changes and sectoral diversification that characterise agricultural transformation in developing countries. Households may reap the rewards from schooling through abandoning or limiting one activity in favour of another. A low or negative return to schooling in crop production, for example, may mean that the more educated have shifted to other activities such as non-farm employment. Similarly, this logic holds for all assets. If the government puts a paved road through to a community, this may cause some households in that community to alter income-generating activities. Researchers focusing on a single activity may find that investment in infrastructure reduces income from that activity, which may lead to perverse policy implications. While this may be the case, analysis of a single activity ignores the benefits of infrastructure in other activities. Only through considering all income-generating activities simultaneously can this problem be avoided. The issue we want to examine in this paper is the relative importance of different assets in the activities chosen by rural Mexican households, with particular emphasis on social and public assets.

The household's decision on the allocation of assets across activities is a simultaneous decision and one that is censored by the fact that households do not necessarily participate in all possible activities. Some households will therefore have zero income from, for example, self-employment.[2] Examining the allocation and returns to assets requires a simultaneous equation model in which the dependent income variables are censored by unobservable latent variables influencing

[1] The types of capital that households access can be categorised in a variety of manners. One common categorisation is to define four types of capital: natural, human-made (physical), human and social (Serageldin and Steer, 1994). Our categorisation reflects a desire to provide greater detail in the types of capital used by households although each of these categories can be subsumed in one of the four categories commonly presented.

[2] Table 1 notes the participation rates for each activity. Less than half of households participate in non-agricultural wage employment, agricultural wage employment, self-employment and migration.

Table 1
Income and activities

Household income	
Mean household income	10888
Crop income	
Mean income for all households	3331
Percent of total household income	30.6%
Percent participating	93.7%
Mean income for participating households	3554
Percent of income for participating households	32.6%
Livestock income	
Mean income for all households	2071
Percent of total household income	19.0%
Percent participating	75.3%
Mean income for participating households	2750
Percent of income for participating households	24.9%
Self-employment income	
Mean income for all households	1234
Percent of total household income	11.3%
Percent participating	28.2%
Mean income for participating households	4378
Percent of income for participating households	33.0%
Non-agricultural wage income	
Mean income for all households	2946
Percent of total household income	27.1%
Percent participating	42.3%
Mean income for participating households	6968
Percent of income for participating households	52.8%
Agricultural wage income	
Mean income for all households	582
Percent of total household income	5.3%
Percent participating	17.2%
Mean income for participating households	3388
Percent of income for participating households	31.0%
Remittance income	
Mean income for all households	724
Percent of total household income	6.6%
Percent participating	15.8%
Mean income for participating households	4570
Percent of income for participating households	32.1%

Number of households = 972.

the activity participation decision. Households obtain income from an activity only if they participate in that activity. Participation in an income-generating activity occurs if the household believes the expected returns to that activity are greater than the alternative of not participating.

The econometric approach follows Lee's generalisation of an estimation principle of Amemiya (1977a,b) in a general simultaneous equation model. Lee (1978) compared Amemiya's generalised two-stage estimators with other two-stage estimators, and showed that Amemiya's estimators are more efficient in all cases, including those proposed by Heckman. This econometric specification allows for censored dependent variables, where unobservable latent variables influence the decision to participate in an activity. Recently, Taylor and Yunez-Naude (2000) utilised Lee's generalisation in their study of returns to schooling in both crop and non-crop activities in rural Mexico and we follow their empirical approach. In the first step, probits using the complete set of asset variables as explanatory variables are estimated. The probit on each income-generating activity measures the effects of assets on household participation in that activity. The probits are also used to calculate inverse Mill's ratios (IMR), which are included in the second step to control for selectivity bias. The second step is to estimate the income equations, including an IMR as a right-hand side variable in each of the corresponding income equations. The income equations are estimated jointly, to reflect the simultaneous nature of the decision, for the full household sample using three stage least squares which allows the inclusion of information contained in the cross-equation error correlations. For the income equations, only assets that are expected to affect the income level of that activity are included as right-hand side variables.

The data used in this study comes from a nationally representative sample of Mexican ejido, or land reform, households.[3] Data were collected at two points in time during the Spring and early summer of 1994 and 1997, for 972 households.[4] The survey covered a wide array of household assets as well as household

[3] The ejido is the land reform mechanism utilised by the Mexican government from the 1930s to 1992. Land and water resources were granted to a community or a group of producers, or ejido, with each producer obtaining usufruct rights over a parcel and access to common lands. A 1992 constitutional reform ended the distribution of land and established a process by which individual titles may be provided to ejidatarios, and by which ejidos may decide to privatise individual parcels. The ejido sector covers 75% of all agricultural producers in Mexico (roughly 3 million households), and over half of the country's irrigated and rainfed land.

[4] The Secretariat of Agrarian Reform and the World Bank carried out the surveys with assistance from the University of California, Berkeley. A detailed description of the Mexico data and its sampling properties can be found in Cord et al. (1998).

demographics, income-generating activities and participation in organisations. Community-level data was also collected on characteristics and organisation of the ejido. Most of the data used in this analysis, including the income data, is from the 1997 survey except in some cases where 1994 data was used to avoid endogeneity problems.

3. Assets and income-generating activities

Household activities can be divided into six categories: crop production, livestock production, self-employment, non-agricultural wage employment, agricultural wage employment and migration. Table 1 presents data on these activities. On average households earned 10,888 pesos in 1997. Not all households participate in every activity. A majority of households participate in crop (93.7%) and livestock (75.3%) production but few participate in self-employment (17.2%) and migration (15.8%). Agricultural activities (crops, livestock and agricultural employment) make up 55% of total rural household income showing that nearly half of income is generated by non-agricultural activities. Crop income represents about 30% of total income in 1997 and is the most important source of income followed by non-agricultural wage income (27.1%). However, only 42.3% of households participate in non-agricultural wage employment and for those that do, it is the most important income-generating activity (52.8% of total income). Similarly, households that participate in self-employment and migration receive, on average, one-third of their income from this activity. A number of agricultural households have thus shifted away from agricultural to non-agricultural activities.

Asset ownership varies significantly across the ejido sector. In Table 2, explanatory assets are grouped into the following categories—natural (land), physical (livestock, equipment), human (education, gender, labour, labour experience and ethnicity), financial (credit), and migration (US and Mexico migration networks) capital. Regional variables are also included to control for unobserved factors. On average, households have substantially less irrigated land than either rainfed or pasture land. For the 25% of households with irrigated land, average size is 5.2 ha. Although overall households hold an average of 6.4 heads of cattle, over half own no livestock. Those households with livestock own on average 13.5 heads. Education level is divided by gender as we hypothesise that the returns to human capital vary by this differentiation. As would be expected, the average number of male and female household members decreases with increasing levels of education. Labour composition and experience vary significantly across households.

Table 2
Assets

Capital	Variable	Mean or percent
Natural	Irrigated land (ha)	1.3
	Rainfed land (ha)	7.5
	Pasture land (ha)	4.3
Physical	Livestock ownership, 1994	6.4
	Tractor ownership, 1994	7.5%
	Truck ownership, 1994	17.1%
Human	Males education—literate	0.7
	Males education—primary	0.5
	Males education—secondary	0.3
	Males education—tertiary	0.1
	Females education—literate	0.6
	Females education—primary	0.5
	Females education—secondary	0.2
	Females education—tertiary	0.1
	Age of head	51
	Male head of household	97.0%
	Males, 15–34 years	0.9
	Females, 15–34 years	0.9
	Males, 35–59 years	0.6
	Females, 35–59 years	0.6
	Non-agricultural wage earner, 1994	34.0%
	Agricultural wage earner, 1994	16.0%
	Self-employed, 1994	9.7%
	HYV seed used, 1994	21.9%
	Chemicals used, 1994	49.2%
	Indigenous household	21.2%
Financial	Formal credit access, 1994	28.8%
Migration	Migrant network in US	1.8
	Migrant network in Mexico	11.0
Regional	North	20.9%
	North Pacific	11.5%
	Centre	26.7%
	Gulf	17.0%
	South	24.0%

Number of households = 972.

Table 3 presents the results of the probits on activity participation for 1997. Coefficients with a level of significance greater than 90% are in bold. Almost all households have some crop production, so results for

Table 3
Probit results for activity participation[a]

	Crop production		Livestock production		Self-employment		Non-agricultural wage employment		Agricultural wage employment		Remittance income	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Irrigated land (ha)	−0.021	0.21	**−0.030**	**0.05**	0.015	0.28	−0.004	0.74	−0.014	0.50	0.011	0.47
Rainfed land (ha)	0.015	0.21	**0.145**	**0.10**	−0.002	0.69	**−0.018**	**0.00**	**−0.021**	**0.01**	**0.018**	**0.00**
Pasture land (ha)	−0.003	0.72	0.014	0.13	−0.003	0.40	0.000	0.99	0.000	0.93	−0.003	0.62
Livestock ownership, 1994	0.013	0.11	**0.132**	**0.00**	0.003	0.35	**−0.012**	**0.01**	**−0.018**	**0.02**	**−0.010**	**0.06**
Tractor ownership, 1994	0.075	0.80	**−0.588**	**0.01**	**−0.352**	**0.07**	−0.256	0.18	−0.238	0.36	−0.257	0.30
Truck ownership, 1994	0.115	0.59	0.027	0.88	0.049	0.73	−0.056	0.69	0.001	1.00	−0.117	0.51
Males education—literate	−0.083	0.62	**0.215**	**0.06**	−0.012	0.90	**0.187**	**0.05**	0.043	0.69	−0.030	0.81
Males education—primary	−0.114	0.55	0.179	0.15	−0.001	0.99	**0.203**	**0.06**	−0.068	0.58	0.031	0.83
Males education—secondary	−0.100	0.64	0.127	0.36	0.087	0.47	**0.229**	**0.06**	−0.024	0.86	**−0.325**	**0.07**
Males education—tertiary	0.174	0.58	−0.164	0.39	0.136	0.41	**0.270**	**0.10**	−0.204	0.36	**−0.474**	**0.09**
Females education—literate	0.029	0.87	0.173	0.16	−0.062	0.55	0.033	0.75	0.102	0.40	0.025	0.85
Females education—primary	0.047	0.80	−0.007	0.96	0.081	0.46	−0.009	0.93	−0.021	0.88	0.116	0.43
Females education—secondary	−0.280	0.19	−0.172	0.28	0.133	0.31	0.054	0.68	−0.031	0.84	0.245	0.18
Females education—tertiary	−0.300	0.23	−0.134	0.47	0.062	0.70	0.216	0.18	**−0.591**	**0.03**	−0.147	0.56
Age of head	−0.009	0.13	−0.005	0.24	−0.003	0.47	**−0.011**	**0.00**	−0.003	0.42	**0.040**	**0.00**
Male head of housheold	−0.177	0.64	0.350	0.21	−0.008	0.98	−0.175	0.52	−0.305	0.33	0.069	0.86
Males, 15–34 years	0.252	0.18	−0.114	0.32	0.012	0.91	0.014	0.88	**0.226**	**0.05**	−0.098	0.47
Females, 15–34 years	0.006	0.97	0.058	0.64	0.070	0.51	0.125	0.23	0.137	0.27	−0.134	0.36
Males, 35–59 years	**0.356**	**0.04**	−0.058	0.63	0.120	0.26	0.132	0.20	0.157	0.19	0.028	0.85
Females, 35–59 years	−0.205	0.24	0.138	0.29	0.066	0.58	−0.112	0.33	**−0.308**	**0.03**	0.183	0.20
Non-agricultural wage earner, 1994	−0.119	0.15	**−0.116**	**0.09**	−0.016	0.80	**0.249**	**0.00**	**−0.146**	**0.06**	−0.102	0.28
Agricultural wage earner, 1994	**0.351**	**0.03**	−0.019	0.85	−0.120	0.22	−0.091	0.32	**0.318**	**0.00**	**0.357**	**0.00**
Self-employed, 1994	0.147	0.49	−0.183	0.17	**0.610**	**0.00**	−0.044	0.71	0.098	0.47	−0.034	0.86
HYV seed used,1994	0.024	0.91	0.078	0.62	−0.019	0.88	−0.198	0.11	−0.161	0.30	−0.104	0.52
Chemicals used, 1994	**0.525**	**0.00**	0.139	0.27	−0.075	0.46	0.021	0.83	−0.128	0.28	−0.014	0.92
Indigenous household	**0.574**	**0.06**	**0.392**	**0.02**	0.026	0.84	0.079	0.53	0.057	0.71	**−0.568**	**0.02**
Formal credit access, 1994	0.137	0.42	0.130	0.31	0.015	0.89	0.008	0.94	0.015	0.91	−0.104	0.47
Migrant network in US	0.024	0.40	**−0.047**	**0.03**	0.001	0.95	−0.014	0.34	−0.036	0.11	**0.204**	**0.00**
Migrant network in Mexico	0.007	0.65	0.006	0.57	0.006	0.47	0.010	0.20	0.015	0.12	0.002	0.89
North	−0.395	0.13	**0.690**	**0.00**	0.073	0.64	**0.746**	**0.00**	**0.726**	**0.00**	−0.032	0.88
North Pacific	**−0.816**	**0.01**	−0.209	0.35	−0.261	0.21	0.025	0.90	0.315	0.23	**−0.585**	**0.04**
Center	−0.055	0.82	**0.606**	**0.00**	0.065	0.63	**0.425**	**0.00**	**0.355**	**0.04**	0.061	0.74
Gulf	0.599	0.18	**1.379**	**0.00**	**0.599**	**0.00**	**0.512**	**0.00**	**0.623**	**0.00**	−0.142	0.55
Constant	**1.739**	**0.00**	−0.570	0.14	**−0.909**	**0.01**	−0.332	0.35	**−0.969**	**0.02**	**−3.730**	**0.00**

Number of households = 972.

[a] Coefficients with a level of significance greater than 90% are indicated in bold.

Table 4
Selectivity-corrected systems estimates of income equations[a]

	Crop production		Livestock production		Self-employment		Non-agricultural wage employment		Agricultural wage employment		Remittance income	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Irrigated land (ha)	**804.0**	**0.00**	**114.0**	**0.01**	**100.1**	**0.00**	−51.5	0.50	23.6	0.35	**63.2**	**0.05**
Rainfed land (ha)	1.7	0.96	**48.0**	**0.00**	**32.2**	**0.01**	23.9	0.42	3.7	0.71	−0.7	0.96
Pasture land (ha)	−2.4	0.93	4.2	0.68	8.9	0.32	−7.8	0.68	−5.4	0.40	−1.2	0.88
Livestock ownership, 1994	−3.5	0.90	**133.6**	**0.00**	2.0	0.84	21.5	0.39	5.3	0.56	11.1	0.28
Tractor ownership, 1994	**4611.5**	**0.00**										
Truck ownership, 1994	565.3	0.60	**1018.2**	**0.01**	−259.3	0.47	538.3	0.48	112.5	0.66		
Males education—literate	75.2	0.92	−294.2	0.34	−10.8	0.97	810.6	0.18	231.2	0.23	−106.9	0.66
Males education—primary	616.8	0.47	**−714.5**	**0.04**	240.0	0.42	**1730.5**	**0.01**	57.8	0.79	−191.4	0.49
Males education—secondary	585.7	0.54	−373.6	0.33	428.3	0.20	**1245.9**	**0.09**	45.0	0.85	30.8	0.93
Males education—tertiary	**3516.0**	**0.01**	−719.7	0.17	634.1	0.18	**2627.7**	**0.01**	−98.0	0.77	204.9	0.67
Females education—literate	−47.2	0.95	−124.6	0.70	45.1	0.87	−346.4	0.56	−69.0	0.73	352.8	0.18
Females education—primary	791.1	0.36	**602.7**	**0.08**	176.6	0.56	−704.5	0.27	−43.7	0.84	56.4	0.84
Females education—secondary	308.5	0.78	538.5	0.20	**625.3**	**0.09**	−787.5	0.31	−164.5	0.52	−307.1	0.37
Females education—tertiary	**3596.2**	**0.01**	**987.0**	**0.05**	**896.5**	**0.04**	**1668.7**	**0.08**	92.5	0.80	**1443.5**	**0.00**
Age of head	−18.1	0.54	−1.9	0.87	4.0	0.70	**41.8**	**0.07**	10.8	0.13	−29.5	0.13
Male head of household	−1610.2	0.45	53.5	0.95	**1333.0**	**0.07**	−1736.7	0.27	**−1134.2**	**0.03**	607.0	0.38
Males, 15–34 years	−1134.1	0.16	433.1	0.17	−140.7	0.61	−379.1	0.52	183.9	0.37	181.1	0.48
Females, 15–34 years	−910.3	0.28	−516.5	0.12	−85.6	0.77	**1119.0**	**0.07**	153.4	0.46	35.8	0.90
Males, 35–59 years	178.7	0.84	48.3	0.88	−96.0	0.74	−511.7	0.41	157.6	0.45	−137.4	0.61
Females 35–59	768.9	0.40	**−674.9**	**0.06**	−14.0	0.96	646.9	0.33	−220.3	0.35	25.2	0.93
Non-agricultural wage earner, 1994							532.5	0.18				
Agricultural wage earner, 1994							249.4	0.64	190.2	0.19		
Self-employed, 1994					**2453.5**	**0.00**						
HYV seed used,1994	1081.6	0.25	352.3	0.35								
Chemicals used, 1994	306.1	0.72	433.1	0.15								
Indigenous household	−1008.6	0.31	356.4	0.34	−192.3	0.57	**−1628.6**	**0.02**	−197.3	0.39	463.4	0.25
Formal credit access, 1994	−498.4	0.53	−77.0	0.81	−320.9	0.25	71.7	0.90	−96.0	0.63	−307.9	0.25
Migrant network in US											−4.8	0.95
Migrant network in Mexico											−15.4	0.46
Inverse mills ratio	**−8422.3**	**0.03**	**−2119.8**	**0.00**	−138.0	0.83	**−3232.4**	**0.01**	**−679.9**	**0.03**	**−1382.0**	**0.01**
Constant	4954.4	0.07	**1865.4**	**0.10**	−1002.9	0.44	3116.4	0.16	**1827.9**	**0.02**	**4184.4**	**0.05**

Number of households = 972.

[a] Coefficients with a level of significance greater than 90% are indicated in bold.

that activity are not particularly interesting. Rainfed land and livestock ownership positively influence participation in livestock production while irrigated land and tractor ownership are negatively associated with livestock participation. This is not surprising since these latter assets are likely to have higher returns for crop production. For a similar reason, tractor owners are less likely to participate in self-employment. Natural and physical capital reduces participation in both forms of wage employment. The positive association between rainfed land and remittance income may indicate that participation in migration requires at least a minimal wealth level. Education, particularly among males, plays a strong role in non-agricultural wage employment. Minimal male education, or literacy, seems to play a similar role in livestock production. Higher levels of male education are negatively associated with receipt of remittances. Younger households (as indicated by age of household head) are more likely to participate in agricultural wage employment, and older households in receiving remittances. The presence of young males, controlling for education, leads to increased participation in agricultural wage labour, while the presence of older males leads to greater participation in crop production. Previous experience in non-agricultural activities (self-employment and non-agricultural wage earning), not surprisingly, leads to a greater probability of participation in each respective activity. However, previous experience in agricultural wage employment leads to greater participation in crop production, agricultural wage earning and migration. Somewhat surprisingly, access to formal credit in 1994 does not influence participation in any activities in 1997. This could be because credit is primarily tied to crop production. Indigenous households are more likely to participate in on-farm activities and less likely to migrate. A number of regional variables are associated with particular activities suggesting there are certain regional factors that influence participation that are not controlled for in the regression. Finally, migration networks are most important for receiving remittance income.

Table 4 presents the results of the selectivity corrected system estimates of the income equations. While the probits evaluated the probability of participation in activities, the income equations examine the factors influencing the level of income from each activity. Note that in all estimates, except for self-employment, the IMR is significant at the 95% level or above. This indicates that self-selection into activities is an important factor in considering the income-generated from a particular activity and failure to control for this would have led to biased results.

Assets play a variety of roles in terms of the generation of income by activity. Land size, particularly irrigated land, is important for on-farm categories as well as self-employment and remittances. Rainfed land is important for livestock income, as it serves as an input into livestock production. Rainfed land is also important for self-employment suggesting that farmers with more land are able to earn more through self-employment than others. Education provides the most interesting story. Education is most important, not surprisingly, for non-agricultural wage labour, though this varies by gender. All levels of male education lead to higher off-farm income, while only the highest level of female education has a positive—and significant—coefficient. On the other hand, the number of females aged 15–34 years, holding education constant, has a positive and significant effect, signalling that lower levels of female education are not valued on the labour market. This is presumably due to the kind of entry level employment rural women can choose from, such as domestic servant. Female education is also important for self-employment income, and surprisingly, livestock income. Both higher levels of male and female education are associated with higher agricultural income, suggesting that education only becomes important when it reaches a certain technical level.

4. Adding social and public capital

The purpose of this section is to discuss a method for the inclusion of community variables, including social and public capital, in the analysis of income-generating activities and to present the results of the analysis. There has been some debate over the precise definition and measure of social capital (Woolcock and Narayan, 2000). Social capital can be defined as a variety of different entities with two common elements: they all consist of some aspect of social structure and they facilitate actions of actors within that structure (Coleman, 1988). For our purposes, social capital constitutes the social relations, both vertical and horizontal, that help facilitate the

generation of income. Since our interest is in examining the community factors that facilitate income generation, we focus on relations at that level. Households may belong to a set of formal and informal organisations that may provide direct or indirect assistance in economic activities. For example, membership in a women's group may provide information on market opportunities for non-farm products. In addition to membership in individual organisations, the ejidos in which households live may be well or poorly organised which will also affect the households' ability to generate income. Finally, vertical ties to, for example, organisations that provide technical assistance will influence income-generation. Each of these is considered as part of social capital. Another asset that is difficult to measure and plays an important role in income generation is public capital, which involves access to public goods and services. These include a range of services and infrastructure from health care and telephone access to electricity and paved roads.

Calculating the value of social and public capital is complicated by the diversity and multiplicity of indicators. Households belong to a range of organisations both formal and informal and ejidos may have different types of organisational structure. Infrastructure and services differ in terms of their presence and importance in a community. Table 5 lists a variety of community variables that may be used as public and social capital indicators. They range from measures of ejido organisation and household participation in organisations to the distance to various public services,

Table 5
Social and public capital variables

	Mean or percent
Kilometers to health centre	8.8
Kilometers to post office	19.7
Kilometers to telegraph	27.8
Kilometers to fax machine	27.4
Time to nearest urban centre (h)	53.6
Distance to nearest urban centre (h)	25.2
Number of rural centres within 1 h	2.6
Number of urban centres within 1 h	1.6
Share of roads that are paved	50.7%
Ejido has a DICONSA store	50.3%
Ejido has a meeting room	49.7%
Ejido has public lighting	74.7%
Ejido has a secondary school	45.7%
Ejido has a high school	7.3%
Household has access to LICONSA store	18.6%
Household water access	
Household has access to emergency work	11.0%
No piped water access	34.7%
Access to piped water outside the house	14.8%
Access to piped water inside the hoouse	50.5%
Household sewage access	
No sewage system access	43.8%
Access to whole in the ground	9.6%
Access to septic system	33.9%
Access to a piped sewage system	12.8%
Household latrine/bathroom access	
No access to latrine or bathroom	23.6%
Access to a latrine	43.5%
Access to a bathroom	32.9%
Household has access to electricity	87.7%
Household telephone access	
No telephone access	41.1%
Access to a public phone	53.6%
Access to a phone at home	5.4%
Ejido belongs to aric	3.1%
Ejido belongs to a ejido union	23.4%
Ejido belongs to a campesino organization	72.1%
Stage of PROCEDE reform	
Not intitiated	35.1%
In process	17.3%
Completed	47.6%
Household participates in family project	2.9%
Household participates in production organisation	11.3%
Household participates in irrigation project	4.3%
Household participates in UAIM	2.3%
Household participates in other formal organisation	7.6%
Household participates in informal organisation	16.4%
Household is in a production contract	6.2%
Household receives technical assistance	14.9%
Share of households speaking indigenous language	20.8%
Ejido has environmental problems	44.5%
Frequency of household particpation in assemblies	
Rarely/never particpate	4.2%
Sometimes participate	16.6%
Always participate	79.2%
Degree of household respect for community agreements	
Rarely/never respect agreements	5.5%
Sometimes respect agreements	20.8%
Always respect agreements	73.8%
Household agrees with use of common lands	72.6%
Communal lands per capita (ha)	25.2
Total ejido population	200.9

Number of households = 972.

the level of community infrastructure and direct household access to publicly provided infrastructure.

The challenge for analysing the benefits of social and public capital in income-generating activities is determining a method for using the information contained in this large set of variables. Two options have generally been used. The first is to create a single numerical index that is a weighted average of the relevant set of variables. A higher value for the index implies, for example, greater social capital. The index is then used in subsequent analysis such as regression analysis of income generation. Narayan and Pritchett (1999) use this approach to examine household income generation in rural Tanzania. The problem with this approach is that it requires strong and somewhat arbitrary assumptions about the weights for each variable in the aggregation. Furthermore, this method assumes that a single numerical index is sufficient to represent social or public capital. However, as with other forms of capital, social and public capital are not homogenous entities. The World Bank (2000), for example, identifies three types of social capital: bonding, bridging and linking. A single index ignores this possibility. Even if multiple indexes were to be created to measure the various types of social or public capital, defining the different indexes would still be arbitrary.

The second approach to including social and public capital variables in income analysis is to use all or a subset of the variables directly in income regressions. For example, De Janvry and Sadoulet (2001) in evaluating the determinants of income in the ejido sector include social and institutional assets (indigenous household and access to technical assistance) and locational characteristics (number of urban centres within 1 h, number of rural centres within an hour and regional dummies). One problem with this approach is in deciding which variables adequately represent the presence of social and public capital. Which variable in Table 5, for example, represents the level of infrastructure in a community? The problem with including all or even a significant number of variables in regression analysis is that this specification can lead to problems with degrees of freedom, if the sample is not sufficiently large, and multicolinearity if, as is likely, the multiple social and public capital variables are highly correlated. In the presence of multicolinearity, identification is not a problem but with highly correlated variables estimates are less precise (Greene, 1997).

Given the shortcomings of these two methods in this paper, a third method, factor analysis, is used to incorporate social and public capital into the analysis of income generation. The primary purpose of factor analysis is to describe the relationships among many variables in terms of a few underlying, but unobservable, *factors* (Johnson and Wichern, 1988). Factor analysis groups sets of variables by their correlations and each group of variables represents a single underlying construct or factor.[5] For example, Kline and Wichelns (1996) use factor analysis to evaluate respondents' perceptions of farmland preservation programs. Based on reasons provided for preserving farmland, they identify four factors that seem to explain preferences: environmental objectives, aesthetic objectives, agrarian objectives and anti-growth objectives. Similarly, using the multiple measures of social and public capital, the underlying factors that represent the important characteristics of these assets can be determined. In one such study, Onyx and Bullen (2000), using a set of 36 measures of social capital from five Australian communities, identify eight factors that represent social capital including community participation, agency and trust. While factor analysis does assist in identifying underlying factors represented by a set of variables, the method is subjective and requires interpretation of the factors to give them meaning. This interpretation relies on previous knowledge and intuition about underlying relationships.

For this study, factor analysis was used to identify factors that represent the important elements of social and public capital. Social and public capital are not necessarily homogeneous and more than one factor was expected to emerge for each set of variables. Social and public capital variables were analysed using the principal component factor method and rotated using the varimax rotation method.[6] Typically, factors

[5] Factor analysis is similar to principal components analysis in that both are attempts to approximate the covariance matrix. However, factor analysis is more elaborate and the primary question it seeks to ask is whether the data are consistent with some underlying structure (Johnson and Wichern, 1988).

[6] As recommended as a first step by Johnson and Wichern (1988). Additional methods including the iterated principal factor method and the maximum likelihood factor method were examined. Since these approaches tended to bring about similar solutions the original principal components factor method was used.

are retained in the analysis if their eigenvalues are greater than one. To limit the number of factors retained the cut-off value was increased to 1.25, which allows for a more straightforward interpretation of factors. Even with this limitation, as will be seen below, interpreting some of the factors is difficult. At that cut-off, eight factors were retained which represented 44% of the variance.[7] Results of the factor analysis are presented in Table 6. As is standard practice, only factor loadings greater than 0.25 are retained for interpretation.[8]

4.1. Factor 1: proximity

This factor indicates the proximity of the community to infrastructure, services and urban areas. This is evidenced by the high negative loadings on distance to a health clinic (−0.45), post office (−0.84), telegraph (−0.80) and a fax (−0.88), and the time (−0.76) and distance to an urban centre (−0.84). Households with a positive association with this factor tend to be less remote than those negatively associated with this factor.

4.2. Factor 2: ejido population size

This factor is associated with ejidos that have a substantial population, which is accompanied by access to substantial community services and infrastructure. The positive associations with DICONSA and LICONSA stores,[9] as well as with the presence of a meeting room, a secondary school and a high school show this. The negative associations with distance to a health centre and to a post office also indicate a large community with access to those services. The negative association with PROCEDE reforms and the positive association with environmental degradation are indicators of the co-operation problems associated with having a large ejido—difficulty in organising the reform process and difficulty in managing the resource base.

4.3. Factor 3: semi-urban

This factor appears to represent ejidos that are semi-urban. The number of urban centres within an hour has a large coefficient (0.62) as does the number of rural centres within an hour (0.35). Hence, it is not surprising to see a positive association with share of roads that are paved, DICONSA store, meeting room, secondary school and telephone access. An ejido near an urban or rural centre is more likely to have greater infrastructure and services. There is also a positive association with the PROCEDE reform. Since this reform leads to the allocation of individual property rights, it is likely to be the case that the reform process will occur in areas where land can be more easily sold or rented, as is generally the case in semi-urban areas. Finally, there is a positive relationship with informal organisation participation. Again this could be associated with a semi-urban setting where populations tend to be denser and organising for cultural and economic reasons is easier.

4.4. Factor 4: co-operation

This factor clearly represents co-operation within the ejido as evidenced by the strong loading on households frequently participating in assemblies (0.72), respecting community agreements (0.71) and belonging to informal organisations (0.40).

4.5. Factor 5: lack of formal production arrangements

This factor describes the lack of formal production organisation in the ejido, as there is a strong negative association with an ejido belonging to an ARIC[10] (−0.63). Furthermore, a substantial number of households associated with this factor do not participate in 'other' formal organisations (−0.54), production contracts (−0.48) and the government technology transfer program (−0.48). There is a somewhat peculiar

[7] This corresponds to the 49% of the variance explained by the eight factors identified by Onyx and Bullen (2000).

[8] While only one set of results is presented, a number of methods of factor analysis were explored. Although the order of the factors differed across method, the results were largely consistent across methods. That is, the loadings and relevance of certain variables tended to be the same across methods suggesting these factors do represent some underlying structure in the data.

[9] LICONSA is a federal program that provides subsidised milk to extremely poor families, urban and rural, with children under 12 years of age, and tortillas to extremely poor families, urban and rural.

[10] ARIC, the Spanish acronym for Rural Associations of Collective Interests, are organisations of ejidos that promote common goals.

Table 6
Factor analysis

Social and public capital variables	Factor 1 Proximity	Factor 2 Ejido size	Factor 3 Semi-urban	Factor 4 Cooperation	Factor 5 Lack formal arrangements	Factor 6 Household access	Factor 7 Infrastructure	Factor 8 Formal organization
Kilometers to health centre	−0.45	−0.27						
Kilometers to post office	−0.84	−0.25						
Kilometers to telegraph	−0.80							
Kilometers to fax machine	−0.88							
Time to nearest urban centre (h)	−0.76		−0.26					
Distance to nearest urban centre (h)	−0.84							
Number of rural centres within 1 h			0.35					
Number of urban centres within 1 h			0.62					
Share of roads that are paved			0.25				0.48	0.28
Ejido has a DICONSA store		0.28	0.34		−0.29			
Ejido has a meeting room		0.41	0.43					
Ejido has public lighting							0.71	
Ejido has a secondary school		0.49	0.31			0.27		−0.32
Ejido has a high school		0.70						
Household has access to LICONSA store		0.35						
Household has access to emergency work								0.41
Household water access						0.46	0.35	
Household sewage access						0.75		
Household latrine/bathroom access						0.72		
Household has access to electricity							0.66	
Household telephone access		0.28	0.31			0.48		
Ejido belongs to aric					−0.63			
Ejido belongs to an ejido union							0.33	0.33
Ejido belongs to a campesino organisation	0.25							0.59
Stage of PROCEDE reform		−0.29	0.49					
Household participates in family project								
Household participates in production org								0.36
Household participates in irrigation project								
Household participates in UAIM								
Household participates in other formal org					−0.54			
Household participates in informal org			0.29	0.40			−0.30	
Household is in a production contract					−0.48			
Household receives technical assistance					−0.48			
Share of HHs speaking indigenous language	−0.39	0.32				−0.30		
Ejido has environmental problems		0.42				−0.26		
Frequency of HH participation in assemblies				0.72				
Household respect for community agreements				0.71				
Household agrees with use of common lands					0.41			
Communal lands per capita (ha)	−0.37							0.32
Total ejido population		0.65						
Eigenvalues	5.26	2.81	2.23	1.77	1.57	1.46	1.33	1.28
Proportion of variance (%)	13.2	7.0	5.6	4.4	3.9	3.7	3.3	3.2

Number of households = 972.

positive association with household agreement on the use of common lands.

4.6. Factor 6: household access to infrastructure

This factor represents the degree to which households have access to services as indicated by the strong loadings on water (0.46), sewage (0.75), bathrooms (0.72) and telephone (0.48) access. Households positively associated with this factor also tend to have a lower share of the population speaking an indigenous language and lower environmental problems. This partially reflects that indigenous households tend to live in more marginalised communities.

4.7. Factor 7: infrastructure

This factor shows the degree of access to infrastructure. This is evident through the strong loadings on public lighting (0.71), electricity (0.66), share of paved roads (0.48) and water access (0.35). The results indicate that ejidos that have formal organisational structures tend to have this type of infrastructure and those with informal organisations are less likely to have the corresponding infrastructure.

4.8. Factor 8: formal ejido organisation

This factor represents an ejido that has a formal organisational structure, indicated by the factor loadings on ejido membership in a campesino organisation (0.59) and ejido union (0.33) as well as the participation in production contracts (0.36). The high loading on communal lands per capita (0.32) may indicate a community with a need for formal structures. Access to emergency work and paved roads may also be an indicator of the community's ability to organise and lobby government officials for assistance.

The results suggest that social and public capital are not homogenous and a number of factors represent their role in income generation. This calls into question the use of single indicators of social or public capital. Using these factor loadings and the regression method suggested by Thomson (1951),[11] a new set of variables representing each of the eight factors can be generated. As is standard practice, the factors are normalised to have a mean value of 0 and standard deviation 1. Using these measures of social and public capital, the two-step econometric procedure outlined in Section 2 and presented in Tables 3 and 4 was repeated. Table 7 presents the new results of the probits for activity participation. The majority of the results remain the same as the preliminary estimations, suggesting their robustness. Results that differ with respect to statistical significance from Table 3 are set in italics.

Participation in activities appears to be influenced by a number of social and public capital factors. Proximity to an urban centre is found to be negatively associated with agricultural wage employment as well as remittance income. This most likely reflects the fact that isolated households have few off-farm options other than agricultural wage employment or migration. Households in ejidos with large populations appear to be less likely to participate in livestock production, reflecting problems in managing the resource base. Not surprisingly, households in a semi-urban setting are more likely to participate in self-employment and non-agricultural wage employment, as the opportunities for households living in these settings are much higher. Receipt of remittance income is less likely in a semi-urban setting and is also negatively associated with infrastructure and formal organisation again suggesting that dependence on external transfers may be the only alternative in the face of limited opportunities. Household access to infrastructure is positively associated with self-employment, as many microenterprises require minimal infrastructure access. Finally, formal organisation in the ejido is positively associated with participation in crop production, livestock production and non-agricultural wage employment. The ejido organisational structure clearly influences the choice of income-generating activities.

Table 8 presents the results of the selectivity corrected system estimates of the income equations including the social and public factors. As with the probits, the majority of the results remain the same as in Table 4. One notable exception relates to male education levels. The results from Table 8 suggest that higher levels of male education are negatively associated with livestock income. Taken together the results suggest that households with significant male education concentrate on non-agricultural wage employment and crop income (for those with tertiary education).

[11] Cited in the STATA reference manual.

Table 7
Probit results for activity participation with social and public capital factors[a]

	Crop production		Livestock production		Self-employment		Non-agricultural wage employment		Agricultural wage employment		Remittance income	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Irrigated land (ha)	−0.011	0.55	**−0.028**	**0.07**	0.010	0.48	−0.001	0.91	−0.008	0.69	0.015	0.36
Rainfed land (ha)	0.013	0.28	*0.013*	*0.13*	−0.001	0.86	**−0.018**	**0.00**	**−0.024**	**0.01**	**0.018**	**0.01**
Pasture land (ha)	−0.002	0.78	0.013	0.16	−0.003	0.38	0.000	0.98	0.000	0.92	−0.004	0.48
Livestock ownership, 1994	0.012	0.12	**0.128**	**0.00**	0.004	0.30	**−0.011**	**0.01**	**−0.018**	**0.02**	**−0.012**	**0.02**
Tractor ownership, 1994	0.111	0.71	**−0.521**	**0.03**	**−0.391**	**0.05**	−0.212	0.27	−0.135	0.61	−0.123	0.63
Truck ownership, 1994	0.177	0.43	0.045	0.80	0.002	0.99	−0.083	0.55	0.012	0.95	−0.157	0.39
Males education—literate	−0.128	0.46	**0.213**	**0.06**	−0.029	0.77	**0.182**	**0.07**	0.049	0.66	−0.047	0.71
Males education—primary	−0.111	0.58	0.204	0.11	−0.032	0.77	**0.200**	**0.07**	−0.052	0.67	0.049	0.74
Males education—secondary	−0.076	0.74	0.177	0.22	0.035	0.77	**0.231**	**0.07**	0.033	0.82	**−0.353**	**0.06**
Males education—tertiary	0.205	0.53	−0.091	0.64	0.044	0.79	**0.288**	**0.09**	−0.067	0.77	**−0.479**	**0.10**
Females education—literate	0.030	0.87	0.177	0.16	−0.057	0.59	0.043	0.68	0.111	0.36	0.033	0.82
Females education—primary	0.047	0.82	0.006	0.96	0.049	0.66	−0.031	0.78	0.010	0.94	0.092	0.55
Females education—secondary	−0.287	0.20	−0.141	0.39	0.087	0.52	0.046	0.73	0.019	0.91	0.263	0.16
Females education—tertiary	−0.330	0.21	−0.081	0.68	−0.005	0.98	0.191	0.24	**−0.531**	**0.07**	−0.129	0.62
Age of head	−0.006	0.31	−0.004	0.35	−0.003	0.40	**−0.010**	**0.01**	−0.001	0.80	**0.043**	**0.00**
Male head of housheold	−0.238	0.55	0.281	0.32	0.006	0.98	−0.223	0.42	−0.338	0.29	0.101	0.80
Males, 15–34 years	0.251	0.20	−0.156	0.19	0.049	0.63	0.021	0.84	**0.206**	**0.07**	−0.095	0.49
Females, 15–34 years	0.024	0.90	0.063	0.62	0.091	0.40	0.136	0.20	0.120	0.34	−0.131	0.39
Males, 35–59 years	**0.404**	**0.02**	−0.072	0.55	0.148	0.17	0.141	0.17	0.147	0.23	0.030	0.84
Females, 35–59 years	−0.194	0.28	0.156	0.24	0.078	0.51	−0.105	0.36	**−0.324**	**0.02**	0.178	0.24
Non-agricultural wage earner, 1994	−0.099	0.25	*−0.087*	*0.21*	−0.031	0.62	**0.252**	**0.00**	**−0.135**	**0.09**	−0.058	0.55
Agricultural wage earner, 1994	**0.335**	**0.04**	−0.037	0.72	−0.101	0.31	−0.096	0.30	**0.311**	**0.00**	**0.361**	**0.00**
Self-employed, 1994	0.199	0.39	−0.168	0.21	**0.611**	**0.00**	−0.043	0.72	0.103	0.46	−0.083	0.68
HYV seed used,1994	0.033	0.88	0.073	0.65	−0.079	0.54	***−0.241***	***0.06***	−0.144	0.37	−0.068	0.69
Chemicals used, 1994	**0.585**	**0.00**	0.149	0.25	−0.099	0.35	0.044	0.67	−0.096	0.44	0.071	0.62
Indigenous household	*0.397*	*0.22*	**0.414**	**0.03**	0.079	0.59	−0.002	0.99	−0.094	0.58	**−0.735**	**0.01**
Formal credit access, 1994	0.173	0.32	0.127	0.33	−0.038	0.72	−0.031	0.77	0.031	0.81	−0.134	0.38
Migrant network in US	0.030	0.30	**−0.044**	**0.04**	−0.003	0.87	−0.011	0.47	−0.034	0.14	**0.212**	**0.00**
Migrant network in Mexico	0.006	0.69	0.004	0.72	0.004	0.61	0.009	0.29	0.014	0.16	0.003	0.82
North	***−0.547***	***0.09***	**0.523**	**0.02**	−0.124	0.52	**0.543**	**0.00**	**0.696**	**0.00**	0.014	0.96
North Pacific	**−0.866**	**0.01**	−0.290	0.23	***−0.392***	***0.08***	−0.064	0.77	0.380	0.18	**−0.587**	**0.05**
Center	−0.027	0.92	**0.552**	**0.00**	−0.054	0.72	**0.339**	**0.02**	**0.346**	**0.08**	0.199	0.32
Gulf	0.683	0.19	**1.280**	**0.00**	**0.384**	**0.04**	*0.193*	*0.31*	**0.405**	**0.09**	−0.119	0.70
F1—proximity	−0.059	0.57	−0.047	0.52	0.001	0.99	−0.046	0.40	**−0.111**	**0.08**	**−0.158**	**0.07**
F2—ejido size	0.119	0.21	**−0.138**	**0.02**	−0.002	0.97	0.050	0.30	−0.056	0.35	0.073	0.32
F3—semi-urban	−0.131	0.18	−0.061	0.36	**0.115**	**0.03**	**0.099**	**0.06**	0.042	0.53	**−0.139**	**0.09**
F4—cooperation	0.064	0.41	0.071	0.22	−0.040	0.42	0.022	0.64	0.087	0.14	0.057	0.41
F5—lack formal arrangements	0.062	0.45	0.044	0.49	−0.029	0.59	0.025	0.63	0.080	0.28	−0.025	0.74
F6—household access	−0.059	0.55	−0.021	0.76	**0.163**	**0.00**	−0.023	0.67	**−0.204**	**0.00**	0.123	0.12
F7—infrastructure	−0.068	0.48	−0.028	0.67	0.001	0.98	−0.026	0.61	0.015	0.80	**−0.137**	**0.07**
F8—formal organization	**0.186**	**0.03**	**0.150**	**0.02**	0.064	0.21	**0.156**	**0.00**	0.073	0.22	**−0.191**	**0.01**
Constant	**1.684**	**0.00**	−0.470	0.26	**−0.703**	**0.06**	−0.165	0.65	**−1.062**	**0.02**	**−4.080**	**0.00**

Number of households = 972.
[a] Coefficients with a level of significance greater than 90% are indicated in bold. Results that differ with respect to statistical significance from Table 3 are set in italics.

Table 8
Selectivity-corrected systems estimates of income equations with social and public capital factors[a]

	Crop production		Livestock production		Self-employment		Non-agricultural wage employment		Agricultural wage employment		Remittance income	
	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value	Coefficient	*P*-value
Irrigated land (ha)	**780.8**	**0.00**	**103.6**	**0.02**	**74.7**	**0.04**	−62.6	0.43	19.5	0.45	**55.9**	**0.09**
Rainfed land (ha)	22.2	0.55	**52.2**	**0.00**	**35.3**	**0.01**	49.6	0.15	11.8	0.31	3.5	0.79
Pasture land (ha)	1.8	0.95	5.7	0.58	9.5	0.30	−1.3	0.95	−4.5	0.49	−2.2	0.79
Livestock ownership, 1994	−12.7	0.66	**126.0**	**0.00**	0.7	0.95	36.1	0.18	11.4	0.26	8.2	0.43
Tractor ownership, 1994	**4253.6**	**0.00**										
Truck ownership, 1994	308.9	0.77	**875.6**	**0.03**	−314.4	0.40	330.4	0.67	143.0	0.58		
Males education—literate	147.6	0.85	−352.9	0.25	−25.6	0.92	656.4	0.28	218.3	0.26	−132.6	0.59
Males education—primary	495.0	0.56	**−870.0**	**0.01**	158.4	0.60	**1528.3**	**0.02**	55.1	0.80	−226.9	0.41
Males education—secondary	382.9	0.69	***−654.7***	***0.09***	214.8	0.53	*786.3*	*0.31*	−15.6	0.95	−65.2	0.85
Males education—tertiary	**2958.4**	**0.03**	***−1072.0***	***0.04***	336.8	0.47	**2002.5**	**0.05**	−129.2	0.70	60.2	0.90
Females education—literate	24.6	0.98	−180.4	0.57	49.0	0.86	−508.7	0.40	−119.0	0.56	356.5	0.17
Females education—primary	790.0	0.37	*539.6*	*0.12*	113.3	0.71	−842.4	0.19	−67.3	0.76	91.7	0.75
Females education—secondary	347.4	0.75	327.2	0.43	*442.2*	*0.23*	−1200.1	0.13	−230.9	0.38	−234.9	0.50
Females education—tertiary	**3370.4**	**0.01**	*709.6*	*0.16*	*682.6*	*0.13*	1139.5	0.24	205.9	0.58	**1365.0**	**0.00**
Age of head	−37.8	0.20	−8.8	0.45	0.8	0.94	**44.1**	**0.07**	9.2	0.20	−19.2	0.32
Male head of housheold	−1047.7	0.62	285.9	0.74	**1560.7**	**0.04**	−1237.4	0.44	**−998.5**	**0.07**	534.8	0.44
Males 15–34	−1071.2	0.18	***603.3***	***0.06***	−21.4	0.94	−350.2	0.55	151.5	0.47	190.8	0.46
Females 15–34	−871.0	0.30	−454.3	0.17	−62.9	0.84	**1165.3**	**0.07**	136.2	0.52	−6.3	0.98
Males 35–59	72.2	0.93	82.7	0.80	−102.4	0.73	−714.9	0.26	100.7	0.63	−81.5	0.76
Females 35–59	876.6	0.33	**−659.6**	**0.06**	−26.7	0.93	961.9	0.15	−116.3	0.65	39.8	0.89
Non-agricultural wage earner, 1994							258.8	0.56				
Agricultural wage earner, 1994							337.9	0.52	137.7	0.38		
Self-employed, 1994					**2278.8**	**0.00**						
HYV seed used,1994	765.9	0.43	239.5	0.53								
Chemicals used, 1994	18.4	0.98	149.2	0.64								
Indigenous household	1217.2	0.28	708.4	0.11	−34.0	0.93	**−1646.0**	**0.05**	−316.0	0.26	602.3	0.21
Formal credit access, 1994	−672.4	0.41	−190.5	0.55	−395.9	0.17	83.4	0.89	−93.1	0.65	−332.1	0.22
Migrant network in US											34.9	0.66
Migrant network in Mexico											−17.8	0.40
F1—Proximity	**1187.9**	**0.01**	297.2	0.07	154.5	0.29	158.3	0.61	71.4	0.53	−22.4	0.87
F2—Ejido size	−508.3	0.19	105.6	0.50	96.4	0.47	−0.2	1.00	87.6	0.38	−103.3	0.41
F3—Semi-urban	**−715.5**	**0.05**	122.7	0.40	156.0	0.32	−250.6	0.41	70.9	0.44	**222.8**	**0.09**
F4—Cooperation	−411.8	0.27	−231.3	0.12	−105.2	0.41	−90.7	0.74	53.5	0.58	−59.0	0.62
F5—Lack formal arrangements	**−635.8**	**0.10**	**−322.2**	**0.04**	**−252.5**	**0.05**	−106.1	0.73	−52.7	0.61	66.5	0.57
F6—Household access	**1112.4**	**0.01**	**600.7**	**0.00**	**302.1**	**0.07**	**631.3**	**0.04**	17.8	0.88	24.6	0.86
F7—Infrastructure	−509.0	0.17	190.5	0.20	120.2	0.35	**783.5**	**0.01**	**186.1**	**0.05**	−87.9	0.49
F8—Formal organization	−196.0	0.59	**−277.4**	**0.06**	−198.9	0.12	−195.2	0.57	−104.7	0.30	3.3	0.98
Inverse Mills Ratio	**−9549.9**	**0.01**	**−2768.0**	**0.00**	−487.1	0.53	**−4731.4**	**0.01**	**−978.3**	**0.02**	**−1045.3**	**0.02**
Constant	**5352.1**	**0.05**	**2597.3**	**0.02**	−458.6	0.74	**4476.5**	**0.06**	**2330.9**	**0.01**	3115.9	0.14

Number of households = 972.

[a] Coefficients with a level of significance greater than 90% are indicated in bold. Results that differ with respect to statistical significance from Table 4 are set in italics.

Moving to the examination of the social and public capital variables, a number of these variables significantly influence the level of income generated from each activity. Proximity to an urban centre positively influences the level of crop income while semi-urban status is negatively associated with crop income. This suggests a non-linear relationship in the benefits of urban access. Households that are very near urban and rural centres are likely to earn less crop income than households further out on the periphery of these centres. However, households that are very far away earn significantly less income. The results also indicate that households with access to basic infrastructure such as water, sewage, bathrooms and telephones earn higher income from crop production. A similar result is found for livestock income, self-employment and non-agricultural wage employment. These results show that a community with substantial household access to these types of infrastructure is likely to have greater income-generating opportunities.

Lack of formal production arrangements appears to limit crop, livestock and self-employment income (meaning that the presence of formal production arrangements would improve income from these sources). These formal production arrangements seem to play an important role in increasing the level of income received by households. However, formal ejido organisation is negatively associated with livestock income. These results provide evidence for the view that the types of social and public capital matter. Both of these variables are indicators of social capital as they measure associational activity. However, only an association with productive oriented organisations has a positive influence on livestock income. Both non-agricultural and agricultural wage income are positively related to the level of infrastructure. Ejidos with access to electricity, public lighting, water and paved roads, all general indicators of economic development, provide higher wage employment income than those without.

5. Conclusion

Our analysis of households in the Mexico ejido sector shows that a household's asset position has a significant effect on its participation in specific activities as well as on the level of income earned from those activities. Households choose a portfolio of activities and the intensity of involvement in those activities based on their asset position. These results support the livelihoods approach to household behaviour, which argues the importance of assets in determining the capacity of households to undertake certain activities. Furthermore, the results show that partial analysis of income generation—that is, the analysis of a single income-generating activity—can potentially lead to incorrect conclusions about the role of a particular asset in income generation. For example, our results indicate that high levels of male education result in greater participation and returns to non-agricultural wage employment but lower income from livestock production. While these results mirror the general conclusion of Taylor and Yunez-Naude (2000) that returns to schooling vary across activity, we find that education participation and returns differ across gender and that the return to education is primarily through non-agricultural wage employment and crop production. While the returns for crop income for men and women at the highest level of education are similar, lower levels of female education are not valued on the labour market. This is due primarily to the type of employment to which young rural women are limited: domestic help.

Our analysis also shows the critical role that social and public capital play in household participation in activities and the level of income generated by each activity. By using factor analysis, the forty community variables are reduced to four public capital factors—proximity, semi-urban status, household access to infrastructure and general infrastructure; three social capital factors—co-operation, lack of formal production arrangements and formal ejido organisation; and one factor—ejido size—that shows the effect of ejido population on both public and social capital. These factors represent the key underlying community characteristics that are likely to influence household behaviour. Their heterogeneity suggests that each will influence that behaviour in a unique manner, and inclusion of these factors in the regression analysis shows this factor-specific influence. Creation of a single index of social or public capital would have ignored the importance of this heterogeneity, and using a subset of social and public capital variables would have led to ambiguity regarding the reason for the effect since each indicator might represent multiple

components of social and public capital. Factor analysis provides an alternative to these methods and identifies the particular manner in which social and public capital influence income generation. Failure to adequately incorporate social and public capital variables can lead to inaccurate or ambiguous results.

The results from the regression analysis indicate that ejido organisation is important in determining participation in crop and livestock production, non-agricultural wage employment and remittance income. The location of the household relative to urban areas (proximity and semi-urban status) is also important in influencing participation in self-employment, non-agricultural and agricultural wage employment and remittance income. In terms of income levels, lack of formal production arrangements hinders agricultural and livestock income generation, as well as self-employment. The type of infrastructure accessible by the household affects income, with household access to infrastructure associated with greater levels of all kinds of income, with the exception of agricultural wage and remittance, and general infrastructure access associated with higher levels of both types of wage labour. Finally, while being very close to urban or rural centres limits crop production income, intermediate proximity to urban centres improves crop production income.

The findings presented in this paper have a number of implications for Mexican government policy towards the ejido sector. First, although all ejiditarios have access to land, many are no longer dependent on agricultural production for most of their income and are using the assets at their disposal for a number of income-generating activities. Policies designed to improve agricultural production will not necessarily have the desired or expected effect since households may respond by shifting assets to other activities. Government interventions should recognise the potential fungibility of assets and incorporate this into the design of the intervention. In this regard, Mexican government interventions consisting of cash transfers to agricultural producers in the ejido sector, through the PROCAMPO program, give beneficiary households some flexibility in the use of the monetary transfers and have been shown to be effective in alleviating poverty (Sadoulet et al., 2001). Second, social and public capital variables have an important influence on income generation. In designing policies to improve the income-generating capacity of ejiditarios, such as policies to alleviate poverty, the government needs to recognise the role of these factors. In particular, interventions need to recognise and respect the social fabric of the community and include activities to enhance the role of formal and informal organisations. For example, based on the results presented in this paper, if the Mexican government wished to embark on a strategy of improving non-agricultural employment opportunities for ejiditarios, it should begin by understanding the role ejido relationships play and take actions to improve ejido organisation (this might also induce participation in crop and livestock production). Additionally, it should improve household access to both household level and general infrastructure since each of these enhances the level of income earned from non-agricultural employment. Similarly, if the government decided to commit resources to generally improving income levels, investing in household access to infrastructure is likely to have the broadest and greatest impact. Ignoring the role of social and public capital in the ejido sector would constitute a missed opportunity and could prove costly if interventions side-step the social structure of the community.

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References

Amemiya, T., 1977a. The estimation of a simultaneous equation tobit model. Technical report 236. Institute for Mathematical Studies in the Social Sciences, Stanford University.

Amemiya, T., 1977b. The estimation of a simultaneous equation categorisation probit model. Econometrica 46, 1193–1205.

Barrett, C., Reardon, T., 2000. Asset, activity, and income diversification among African agriculturalists: some practical issues. Project report to the USAID BASIS CRSP.

Coleman, J., 1988. Social capital in the creation of human capital. Am. J. Sociol. Suppl., S95–S120.

Cord, L., et al., 1998. Mexico Ejido Reform: Avenues of Adjustment Five Years Later. The World Bank, Latin America and Caribbean Region, Washington, DC.

Corral, L., Reardon, T., 2001. Rural nonfarm incomes in Nicaragua. World Dev. 29 (3), 427–442.

De Janvry, A., Sadoulet, E., 2001. Income strategies among rural households in Mexico: the role of off-farm activities. World Dev. 29 (3), 467–480.

Ellis, F., 2000. Rural Livelihoods and Diversity in Developing Countries. Oxford University Press, Oxford.

Greene, W., 1997. Econometric Analysis. Prentice-Hall, Upple Saddle River, NJ.

Johnson, R., Wichern, D., 1988. Applied Multivariate Statistical Analysis. Prentice Hall, Englewood Cliffs, NJ.

Kline, J., Wichelns, D., 1996. Public preferences regarding the goals of farmland preservation programs. Land Econ. 72 (4), 538–549.

Lanjouw, P., 1999. Rural nonagricultural employment and poverty in Ecuador. Econ. Dev. Cult. Change 48 (1), 91–122.

Lanjouw, P., 2001. Nonfarm employment and poverty in rural El Salvador. World Dev. 29 (3), 529–548.

Lee, L.F., 1978. Simultaneous equation models with discrete and censored dependent variables. In: Manski, P., McFadden, D. (Eds.), Structural Analysis and Discrete Data with Econometric Applications. MIT Press, Cambridge, MA.

Narayan, D., Pritchett, L., 1999. Cents and sociability: household income and social capital in rural Tanzania. Econ. Dev. Cult. Change 47 (4), 871–897.

Onyx, J., Bullen, P., 2000. Measuring social capital in five communities. J. Appl. Behav. Sci. 36 (1), 23–42.

Reardon, T., Berdegue, J., Escobar, G., 2001. Rural nonfarm employment and incomes in Latin America: overview and policy implications. World Dev. 29 (3), 395–410.

Sadoulet, E., de Janvry, A., Davis, B., 2001. Cash Transfer with Income Multiplier: PROCAMPO in Mexico. World Develop. 29 (3).

Serageldin, I., Steer, A., 1994. Making development sustainable: from concepts to action. Environmentally Sustainable Development Occasional Paper Series Number 2. World Bank, Washington.

Taylor, J.E., Yunez-Naude, A., 2000. The returns from schooling in a diversified rural economy. Am. J. Agric. Econ. 82 (2), 287–297.

Thomson, G.H., 1951. The Factorial Analysis of Human Ability. University of London Press, London.

Winters, P., de Janvry, A., Sadoulet, E., 2001. Family and community networks in Mexico–US migration. J. Hum. Res. 36 (1), 159–184.

Woolcock, M., Narayan, D., 2000. Social capital: implications for development theory, research and policy. World Bank Res. Obs. 15 (2), 225–249.

World Bank, 2000. World Development Report 2000/2001: Attacking Poverty. Oxford University Press for the World Bank, New York.