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# *Evaluating poverty duration and transition: A spell-approach to rural China*

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## Abstract

This article uses a discrete-time multivariate duration model to study poverty transition in rural China between 1989 and 2006. The analysis identifies nonlinear negative duration-dependence for both exit and re-entry rates of poverty. There is significant difference in hazard rates of exit and re-entry associated with geographic location and educational level of households, but less related to gender, occupation or ethnic background of household head. The factors facilitating households' ending a poverty spell are found to be education, land ownership, asset accumulation, health insurance and out-migration, while larger family size and dependence ratio may reduce the chance of exit.

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## 1. Introduction

Poverty dynamics in rural China have been well examined from the perspectives of their transient and chronic components (Jalan and Ravallion, 1998a, b, 2000) and the probability of becoming poor (McCulloch and Calandrino, 2003; Zhang and Wan, 2006). While useful for understanding the changes of households' poverty status within a given period, they have weak explanatory power for the persistent poverty which has been emerging since the late 1990s. Chen and Ravallion (2008) find that, although the incidence of poverty dropped sharply by 68 percent between 1981 and 2005, 47 percent of this reduction had happened before 1996. The missing explanatory factor may be "time-varying and individual-specific determinants of households' poverty transitions" (Bigsten and Shimeles, 2008). If so, the spell-approach is more insightful, as it reveals individual households' trajectories of sliding in and out of poverty spells and the determinants of these repeated shifts.

This approach has been widely applied to poverty transitions in developed countries (e.g., in the UK by Devicienti, 2002, 2010; in Italy by Devicienti and Gualtieri, 2007) and a few developing economies (e.g., Ethiopia by Bigsten and Shimeles, 2008). However, little has been known for rural China. As far as we are aware, only Glauben *et al.* (2006) use duration analysis to measure to what extent and how households' individual past (non-)poverty experience affects their probabilities of suffering or escaping poverty in future. Their study shows that past exposure to poverty may be less decisive, because both exit and entry rates of poverty tend to increase at longer duration. Nevertheless, this may lack representativeness for rural China, especially the poor areas, as their samples were selected from Zhejiang province only, which is coastal and one of the richest provinces. Moreover, their hazard model is based on the presumption of underlying continuous data without unobserved heterogeneity, which may be an over-simplification and overestimate (underestimate) negative (positive) duration-dependence and the proportionate response of the hazard to an estimated negative (positive) coefficient (Jenkins, 2005).

This article offers new evidence on the shape and correlates of transition in and out of poverty for rural China, by using a highly representative panel and a discrete-time hazard model controlling for unobserved heterogeneity. The next section sets up the model. Section 3 describes the data and discusses the results. Section 4 concludes.

## Analytical framework

### Modelling poverty duration

There are two states, poverty and non-poverty, between which households shift over time.[1] Following Bigsten and Shimeles (2008), the (discrete) survival time is indexed by $t_1, t_2, \ldots t_j, \ldots t_k$ with equal intervals for simplicity. The rates of exit pertain to households who 'just started a poverty

[1] As Bigsten and Shimeles (2008), there is presumably no correlation between repeated spells for the same household over time, i.e. independence between multiple spells. In fact, we split households into subjects with single-spells and then pooled them for estimation.

spell'.[2] Among them, $d_j$ households end their poverty spells at $t_j$. $n_j$ households stay poor in at least *j* waves and are at 'risk' of moving out of poverty at $t_{j+1}$. The survival function is therefore defined by

$$\hat{S}(t_j) = \prod_{j|t_j \le t} \left(1 - \frac{d_j}{n_j}\right) \quad (1)$$

Correspondingly, the hazard rates for ending a poverty spell at $t_j$ are calculated by

$$h(t_j) = \begin{cases} 1 - \hat{S}(t_j) & if \;\; j = 1 \\ \dfrac{\hat{S}(t_j) - \hat{S}(t_{j-1})}{\hat{S}(t_j)} & if \;\; j > 1 \end{cases} \quad (2)$$

By the same token, the poverty re-entry rates refer to those who just started a non-poverty spell. The hazard rates of ending non-poverty spells are calculated analogously.

Nevertheless, there has been growing concern over spurious transition between the two states. A cause may be the measurement errors in consumption data. A household might be misclassified as 'poor' simply because its consumption seems to fall below a certain poverty line, but this may be a measurement error rather than evidence of adverse events. Following Devicienti (2002), this problem could be addressed by adjusting the poverty line so that households are deemed to be poor (non-poor) only if their per capita consumption falls below (surpasses) 90 (110) percent of the unadjusted poverty line at US$1.25/day.

Another cause is the construction of survival and hazard functions itself. Equations 1 and 2 are essentially aggregate measures of transition into and out of poverty for the full sample, while some households sharing certain characteristics might remain poor/non-poor for a long time. These characteristics can be either observed or unobserved, such as the lack of endowments and intrinsic incapabilities. It is hence necessary to investigate whether the revealed shape of poverty transition is a common feature. In this article, this is done in two ways. Non-parametric estimates of survival and hazard function are replicated for various sub-groups. We also implement a multivariate analysis to explore the correlates of exit from and re-entry into poverty.

**Explaining the correlates of poverty transition**

For the household *i* in the time interval *j*, a standard discrete-time hazard model takes the following specification:

$$h_i(t_j) = \Pr(T_i = t_j \mid T_i \ge t_j) \quad (3)$$

[2] The concept employed here is in line with Devicienti (2002, 2010) and Bigsten and Shimeles (2008). A household just starting a (non-)poverty spell at *t* means it was in (non-)poverty at *t-1* and shifts out of this state at *t*. Our sample contains seven waves of the surveys. Therefore, the first (non-)poverty spell starts at the second wave and the maximum duration is five.

where $T_i$ is the time a (non-)poverty spell ends. Empirically, a complementary log-log hazard function is used to model poverty exit and re-entry rates separately. Following Devicienti and Gualtieri (2007), the probability that household *i* escapes from poverty at duration *d* at time $t_j$, given it has stayed in poverty spells up to $t_j$, is expressed by:

$$e_i\left(d, X_{ij} \mid \upsilon_i^P\right) = 1 - \exp\left[-\exp\left(f^P(d) + X_{ij}'\beta^P + u_i^P\right)\right] \quad (4)$$

where the vector $X_{ij}$ contains household-specific time-varying characteristics; $f^P(d)$ is a function explicitly modelling how exit rates depend on the duration that households have spent in poverty spells; $u_i^P \equiv \log\left(\upsilon_i^P\right)$ denotes the unobserved heterogeneity which is time-invariant and common across *i*'s all poverty spells.[3]

Similarly, the probability that the household *i* re-enters poverty at duration *d* at time $t_j$, given it has been non-poor up to $t_j$, is written by:

$$r_i\left(d, X_{ij} \mid \upsilon_i^N\right) = 1 - \exp\left[-\exp\left(f^N(d) + X_{ij}'\beta^N + u_i^N\right)\right] \quad (5)$$

In order to integrate out the unobservables in estimating the hazard models, normal distributions are assumed for $u_i^P$ and $u_i^N$.[4] To make models more flexible, the baseline hazards $f^P(d)$ and $f^N(d)$ take a fully non-parametric form motivated by Devicienti (2002; 2010): a set of duration-interval-specific dummies, at which households are at risk of shifting out of (non-)poverty spells.

## Data and empirical results

### Data

A balanced panel containing 1,429 rural households is extracted from seven rounds of China Health and Nutrition Surveys (CHNS) in 1989, 1991, 1993, 1997, 2000, 2004 and 2006. The samples are basically equally distributed in seven provinces, from coastal to inland China.[5] Table 1 summarises the variables used in estimation.

[3] Households' initial (non-)poverty status is assumed to be exogenous to their characteristics. Devicienti's (2010) model controls for endogeneity of initial conditions, which may lead to our future research.

[4] We also experimented with Gamma and Heckman and Singer's (1984) mixed mass-point distributions, but maximisation procedures failed to converge to a solution.

[5] Coastal provinces are Jiangsu and Shandong. Central provinces are Henan, Hubei and Hunan. Western provinces are Guangxi and Guizhou.

Table 1 Descriptive statistics

| Variables | 1989 | | 2006 | |
|---|---|---|---|---|
| | Mean | SD | Mean | SD |
| hh per capita consumption | 1 091.130 | 619.025 | 2 350.194 | 1 969.907 |
| hh size | 4.603 | 1.445 | 3.928 | 1.724 |
| age of hh head | 41.713 | 11.506 | 57.532 | 11.091 |
| dependence ratio | 0.350 | 0.236 | 0.369 | 0.373 |
| % male adults | 0.778 | 0.354 | 0.564 | 0.306 |
| % complete primary edu. within the hh | 0.389 | 0.253 | 0.340 | 0.283 |
| % complete at least secondary edu. within the hh | 0.054 | 0.126 | 0.085 | 0.170 |
| ln(farm land) | 0.480 | 1.804 | -0.210 | 2.091 |
| ln(value of agricultural assets) | 2.241 | 3.541 | 2.806 | 4.135 |
| % local off-farm employment within the hh | 0.712 | 0.290 | 0.141 | 0.231 |
| % village out-migration (out-migration networks) | 0.007 | 0.012 | 0.036 | 0.062 |
| % having health insurance within the hh | 0.117 | 0.269 | 0.324 | 0.386 |
| % sown land affected by natural disasters within the province | 0.217 | 0.053 | 0.113 | 0.045 |

*Note*: All monetary variables are in 2006 prices.

Preliminary exploration of transition probabilities suggests co-existence of persistence and transition of poverty in rural China. The upper panel of Table 2 shows that 36.52 percent of households had experienced at least one period of poverty within the sample time span. Among those who were poor at the beginning of the surveys, 58.23 percent ended up in poverty again. The degree of this persistent hardship is even greater (64.09 percent) if measured against the adjusted poverty line. In comparison, however, 80.49 percent of the initially non-poor were likely to retain their livelihood position at the end of the surveys. As one might predict, using the adjusted poverty line makes it harder to remain non-poor (78.04 percent). Meanwhile, there is also evident poverty transition. Of the initially poor households, 41.77 percent successfully moved out of deprivation, while only 19.51 percent of those who were non-poor slipped back into poverty.

Table 2 Poverty transition matrix (%), 1989-2006

| | Poverty | Non-poverty | Total |
|---|---|---|---|
| *Unadjusted poverty line* | | | |
| Poverty | 58.23 | 41.77 | 100 |
| Non-poverty | 19.51 | 80.49 | 100 |
| Total | 36.52 | 63.48 | 100 |
| *Adjusted poverty line* | | | |
| Poverty | 64.09 | 35.91 | 100 |
| Non-poverty | 21.96 | 78.04 | 100 |
| Total | 43.70 | 56.30 | 100 |

**Estimated survival and hazard functions**

The estimated survival and hazard functions in Table 3 indicate strong negative duration-dependence associated with the rates of poverty re-entry. This implies a good chance for

households to escape from poverty in the long term. For those who just started a non-poverty spell, 65.7 percent successfully remained above the unadjusted poverty line, after spending five periods in non-poverty. Their re-entry rates quickly approach to zero. In the case of unadjusted poverty line, if a household has survived for five periods, it has only a 1.6 percent likelihood of sliding into poverty in the next period.

Table 3 Survival and hazard functions of ins and outs of poverty

| Time since the start of spell | Poverty exit | | | |
|---|---|---|---|---|
| | Unadjusted Sur.(s.e.) | Exit (s.e.) | Adjusted Sur. (s.e.) | Exit (s.e.) |
| 1 | 1 (.) | . (.) | 1 (.) | . (.) |
| 2 | 0.779 (0.009) | 0.249 (0.011) | 0.762 (0.009) | 0.270 (0.011) |
| 3 | 0.626 (0.012) | 0.217 (0.014) | 0.626 (0.011) | 0.197 (0.013) |
| 4 | 0.517 (0.013) | 0.191 (0.017) | 0.514 (0.012) | 0.197 (0.016) |
| 5 | 0.314 (0.014) | 0.490 (0.034) | 0.339 (0.013) | 0.409 (0.030) |
| 6 | 0.207 (0.013) | 0.408 (0.044) | 0.235 (0.013) | 0.363 (0.039) |
| Time since the start of spell | Poverty re-entry | | | |
| | Unadjusted Sur. (s.e.) | Re-ent. (s.e.) | Adjusted Sur. (s.e.) | Re-ent. (s.e.) |
| 1 | 1 (.) | . (.) | 1 (.) | . (.) |
| 2 | 0.787 (0.013) | 0.239 (0.017) | 0.787 (0.012) | 0.238 (0.015) |
| 3 | 0.709 (0.015) | 0.104 (0.014) | 0.730 (0.014) | 0.076 (0.010) |
| 4 | 0.680 (0.016) | 0.041 (0.010) | 0.712 (0.014) | 0.024 (0.006) |
| 5 | 0.667 (0.016) | 0.019 (0.007) | 0.702 (0.014) | 0.014 (0.005) |
| 6 | 0.657 (0.017) | 0.016 (0.007) | 0.694 (0.015) | 0.012 (0.005) |

*Note*: Kaplan-Meier estimates.

The exit rates are also negatively associated with duration in the first three periods in poverty for those who just started a poverty spell. In other words, the longer the time spent in poverty, the lower the probability of escape for these households is becoming. The average length of a poverty spell is 2.55 periods, which are equivalent to 5.1 years if counting the real gap of years between surveys. Meanwhile, it is also worth noting that after four periods in poverty, exit rates tend to increase, signalling an opportunity for the poor to escape at longer duration. This seemingly mixed duration-dependence for exit will be examined more carefully by the multivariate analysis in the next sub-section.

As aforementioned, adjusted poverty lines tend to bring about more difficulties for households' sliding into and out of poverty. This is demonstrated by estimates in Table 3. The hazard rates of poverty exit (re-entry) are higher (lower) in the case of adjusted poverty lines, relative to the unadjusted one. In order to best accommodate measurement errors in consumption data, from here, this article keeps using the adjusted poverty lines to split households' poverty/non-poverty episodes in the analysis.

As noted in Section 2, the hazard rates in Table 3 are estimated, based on the assumption of homogenous population. We further consider whether poverty exit and re-entry diverge for categories defined by households' geographic location, nationality, household heads' educational level, gender and occupation. For each of the sub-groups, the differences of hazard rates between sub-categories are examined by log-rank and Wilcoxon tests (Table 4). With respect to the likelihood of exiting poverty, distinction exists across different education levels and regions at one percent significance level, while for the risk of re-entering poverty, variation is only found across regions at 10 percent significance level. As Glauben *et al.* (2006), we also observe first a decreasing and then an increasing relationship between exit rates and the duration of poverty

spells in coastal provinces, but consistently decreasing exit rates in western provinces. Households residing in less developed regions are more likely to be trapped in persistent poverty. This supports our argument that Glauben *et al.*'s (2006) conclusion does not represent the general situation in rural China.

Table 4 Heterogeneity in hazard rates (adjusted poverty line)

| Category | Sub-group | Exit | | Re-entry | |
|---|---|---|---|---|---|
| | | Log-rank test | Wilcoxon test | Log-rank test | Wilcoxon test |
| Region | costal, central, western | 18.85 (0.00) | 3.10 (0.21) | 5.16 (0.08) | 2.62 (0.27) |
| Gender | male, female hh heads | 1.13 (0.29) | 0.43 (0.51) | 1.87 (0.17) | 1.89 (0.17) |
| Occupation | farmer, skilled worker, non-skilled worker, professional | 3.21 (0.36) | 1.80 (0.62) | 5.67 (0.13) | 4.63 (0.20) |
| Education | illiterate, primary, secondary, tertiary | 17.50 (0.00) | 12.69 (0.01) | 0.13 (0.73) | 0.92 (0.82) |
| Nationality | ethnic majority, ethnic minorities | 0.59 (0.44) | 0.06 (0.81) | 0.47 (0.49) | 0.68 (0.41) |

*Note*: *p*-values are in parentheses.

**Correlates of poverty transition**

The LR test (Table 5) shows that unobserved heterogeneity matters in poverty exit, but seems to be less of a problem in re-entry regressions. Negative duration-dependence can be confirmed in cases of both poverty re-entry and exit. However, it would disappear after four periods in non-poverty for the former and two periods in poverty for the latter. The multivariate analysis seems not to support the increasing hazard rates of exit at longer duration revealed by the non-parametric examination. Moreover, the magnitude of estimates suggests that the negative relationship between spell duration and hazard rates is non-linear.

Among various demographic characteristics, larger family size and higher dependence rate are major impediments to poverty exit and drivers of poverty re-entry. Primary education can reduce the risk of re-entry, while secondary and tertiary education is more helpful to chances of escape. Gender and ethnic background of a household head appear not to exert much influence on poverty transitions, while occupation may play a role. Households led by non-farmer heads are more likely to move out of poverty. As expected, more asset accumulation, land ownership, out-migration and health insurance are conducive to shifting out of entrenched deprivation. When researching the impact of aggregate shocks on poverty exit, weather risk features. Compared with coastal provinces, living in less developed western and central regions may also hamper prosperity.

Table 5 Covariates of hazard rates of poverty exit and re-entry

| Indep. variable | Poverty exit regression | | Poverty re-entry regression | |
|---|---|---|---|---|
| | Without heterogeneity | With normal heterogeneity | Without heterogeneity | With normal heterogeneity |
| *Duration dependence* | | | | |
| D1 | -0.335 | -0.329 | -1.101 | -1.098 |
| | (0.080)*** | (0.081)*** | (0.156)*** | (0.156)*** |
| D2 | -0.432 | -0.424 | -2.280 | -2.276 |
| | (0.098)*** | (0.099)*** | (0.287)*** | (0.287)*** |
| D3 | 0.133 | 0.150 | -2.724 | -2.722 |
| | (0.094) | (0.095) | (0.387)*** | (0.387)*** |
| D4 | -0.207 | -0.181 | -3.340 | -3.338 |
| | (0.132) | (0.133) | (0.460)*** | (0.460)*** |
| D5 | -0.080 | -0.044 | -17.009 | -20.807 |
| | (0.141) | (0.143) | (437.001) | (3080.321) |
| *Household characteristics* | | | | |
| hh size | -0.142 | -0.143 | 0.174 | 0.175 |
| | (0.021)*** | (0.021)*** | (0.036)*** | (0.036)*** |
| hh head's age | 0.021 | 0.022 | 0.017 | 0.017 |
| | (0.003)*** | (0.003)*** | (0.005)*** | (0.005)*** |
| % completing primary edu. | 0.173 | 0.173 | -0.388 | -0.390 |
| | (0.111) | (0.113) | (0.230)* | (0.231)* |
| % completing at least sec. edu. | 0.481 | 0.486 | -0.089 | -0.086 |
| | (0.178)*** | (0.182)*** | (0.451) | (0.454) |
| % male adults within hh | 0.044 | 0.049 | -0.160 | -0.160 |
| | (0.100) | (0.102) | (0.192) | (0.193) |
| gender of hh head (male=1) | -0.061 | -0.062 | 0.234 | 0.239 |
| | (0.110) | (0.112) | (0.235) | (0.237) |
| dependency ratio | -0.423 | -0.422 | -0.349 | -0.353 |
| | (0.107)*** | (0.108)*** | (0.225) | (0.226) |
| ethnic minorities of hh head (=1) | 0.035 | 0.039 | 0.097 | 0.098 |
| | (0.121) | (0.123) | (0.268) | (0.270) |
| hh head's occup.: farmer | -0.044 | -0.047 | 0.185 | 0.185 |
| | (0.093) | (0.095) | (0.196) | (0.197) |
| hh head's occup.: unskilled labour | 0.249 | 0.249 | -0.104 | -0.099 |
| | (0.119)** | (0.120)** | (0.279) | (0.281) |
| *Wealth* | | | | |
| ln(farm land) | 0.042 | 0.043 | -0.037 | -0.038 |
| | (0.019)** | (0.019)** | (0.036) | (0.036) |
| ln(value of agri. assets) | 0.024 | 0.024 | -0.038 | -0.037 |
| | (0.008)*** | (0.008)*** | (0.017)** | (0.017)** |
| raising livestock | -0.134 | -0.137 | -0.120 | -0.121 |

| | | | | |
|---|---|---|---|---|
| (yes=1) | (0.069)* | (0.070)* | (0.136) | (0.137) |
| *Access to labour market* | | | | |
| % local off-farm empl. within hh | -1.151 | -1.156 | -1.144 | -1.152 |
| | (0.100)*** | (0.100)*** | (0.196)*** | (0.198)*** |
| village out-mig. networks | 3.090 | 3.184 | 0.205 | 0.187 |
| | (0.661)*** | (0.678)*** | (1.631) | (1.649) |
| *Social protection* | | | | |
| % having health insur. within hh | 0.407 | 0.415 | -0.661 | -0.663 |
| | (0.076)*** | (0.077)*** | (0.230)*** | (0.231)*** |
| *Aggregate shocks* | | | | |
| prov. % land in natural disasters | -9.917 | -10.018 | 1.348 | 1.320 |
| | (0.662)*** | (0.667)*** | (1.062) | (1.068) |
| *Geographic locations* | | | | |
| living in central provinces (yes=1) | 0.738 | 0.752 | -0.135 | -0.135 |
| | (0.082)*** | (0.084)*** | (0.163) | (0.164) |
| living in western provinces (yes=1) | 0.279 | 0.285 | -0.130 | -0.128 |
| | (0.087)*** | (0.089)*** | (0.201) | (0.203) |
| Log-likelihood | -2527.854 | -2529.573 | -839.578 | -839.829 |
| LR test of $\rho = \sigma_u^2/(1+\sigma_u^2) = 0$ (*p*-value) | | 0.032 | | 0.239 |

*Note*: *, **, *** denote 10%, 5% and 1% significance levels. Standard errors are in parentheses.

## Conclusions

The analysis identifies negative duration dependence for poverty exit and re-entry in rural China in the period 1989-2006. This indicates that poverty tends to become a persistent state for those who started out with a poverty spell. Policies aiming to end current poverty may also facilitate households' moving out of poverty in the future. The catalyst for poverty exit and impediments to poverty re-entry include education, asset accumulation, health insurance and out-migration. Living in less developed regions, larger family size and dependence rate reduce the possibility of escape from poverty.

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