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Intercity migration in China: a recurrent-event duration analysis of repeat migration

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This paper focuses on repeat migration of migrant workers in China. We explore repeat migration from the perspective of the duration of each migration stage in one's migration history. The main methodology is a recurrent-event Cox proportional hazard (PH) duration model that examines the effects of both time-independent and time-dependent variables on the potential for repeat migration. We also assess the PH assumption for time-independent variables. We find that the age of first migration, the accompaniment of family members and the types and location of destination cities have significant effects on the potential of migrants' subsequent movements to other cities.

Keywords: repeat migration, Chinese rural migrants, recurrent-event duration model
JEL Classifications: R23, C41, O15

Introduction

Massive rural–urban migration in China is an important feature of Chinese labour markets. The migration process is complex, involving initial movement outside a migrant's place of origin and subsequent movements across different destination cities, referred to as "repeat migration". Repeat migration in China gives rise to important research questions, such as how many times rural migrants will change their place of work and residence before they settle down, how long they stay in a destination city and what factors determine their decisions to move again. Answering these questions would inform migration policies regarding the magnitude and direction of migration flows. This article focuses on repeat migration of Chinese migrant workers from the perspective of the duration of each stage in one's migration history.

The frequent movement of Chinese rural migrants across cities has increasingly drawn researchers' attention. Meng (2012) estimates that rural migrants stay in destination cities for only 7 years on average. Most studies on the temporary nature of rural–urban migration emphasise discrimination against rural migrants in terms of wages, job opportunities, public services and so on, due to lack of the urban *hukou*, the residency registration system in China (Meng and Zhang, 2001; Lu and Song, 2006; Wang et al., 2015; Zhang and Xie, 2013). However, few papers address the duration issue of repeat migration in China. Using a unique data set from a survey conducted by our research team, we use a recurrent-event Cox proportional hazard (PH) duration model to examine the factors affecting the length of migrants' stay in their destination cities. We find that, among other things, age of first migration, the accompaniment of family members in one's migration period and the types and location of destination cities have significant effects on the potential of migrants' subsequent movements to other cities.

Literature review

Since the works of Ravenstein (1884), human migration has usually been seen not as a once-for-all process but as a sequence of movements, categorised into three types: primary (that is, first migration), onward (that is, moving to other destinations after the first migration) and return migrations (that is, returns to a previous place of residence) (Eldridge, 1965; Newbold and Cicchino, 2007). Return and onward migrations, together, are called repeat migration (DaVanzo, 1983). Most theories on repeat migration follow the framework of the life cycle human capital investment model (Dierx, 1988; Kennan and Walker, 2011; Yezer and Thurston, 1976;). Rational migrants optimise utility at each migration stage, under income constraints and both monetary and psychological moving costs (Constant et al., 2013). Imperfect information and location-specific capital are also considered in explaining repeat migration (Allen, 1979; DaVanzo, 1981). Imperfect information causes unsatisfactory experiences of initial migration, triggering either return or onward moves. Location-specific capital, primarily referred to as social network in a place, builds ties to the location of residence, resulting in either returning to the place of previous residence (including origins) or prolonging the stay in one destination region.

Empirical studies evaluate the effects on repeat migration of various factors, including personal characteristics, household characteristics and economic conditions of sending and receiving regions. Eldridge (1965) compared the age group composition of primary, onward and return migration in the USA and found that the age for peak rates of onward and return migration was greater than that of primary migration. DaVanzo (1983) found that within the 1968–1975 period in the USA, younger, less educated and unemployed migrants were more likely to return as a "corrective" move. She also found that well-educated people were more likely to make onward moves. Newbold (2005) and Newbold and Cicchino (2007) investigated repeat migration in Canada at different spatial scales and with different time intervals, revealing that onward migrants tended to be younger, better educated and more skilful than return migrants.

One aspect in empirical studies of repeat migration concerns the duration of migrants staying at destination regions. Although the number of studies on this is small, it has gained more attention in recent years. Most studies on migration duration focus on return migration or circular migration in the international context, such as immigrants from Mexico to the USA (Detang-Dessendre and Molho, 2000; Lindstrom, 1996; Massey and Espinosa, 1997; Reyes, 2001; Vergalli, 2011), and migrant workers between European countries (Constant and Zimmermann, 2011, 2012; Djajić and Milbourne, 1988; Dustmann and Kirchkamp, 2002; Gundel and Peters, 2008). The optimal migration duration is found to be determined by migrants' consumption preference in their home countries (Djajić and Milbourne, 1988), wage differentials between host and home countries (Dustmann, 2003) and comparison of the purchasing power of savings at home and abroad (Stark et al., 1997). Also, gender, marital status, social network, economic opportunities at home countries, plus immigrants' skills and entrepreneurship can influence the length of stay in host countries and the likelihood of circular migration back and forth between host and home countries (Detang-Dessendre and Molho, 2000; Dustmann and Kirchkamp, 2002; Gundel and Peters, 2008). Along with descriptive analysis and logistic models, duration models (or survival analysis) are popular in modelling duration of migration. Many studies use the PH model, including both parametric and semi-parametric methods, to examine determinants of duration of stays in destination regions before returning home (Gundel and Peters, 2008; Lindstrom, 1996; Massey and Espinosa, 1997). To our knowledge, Andrews et al. (2011) is the only case that uses a recurrent-event duration model to examine a complete migration process consisting of primary, onward and return migration, which is in line with our article.

Research papers on migration duration of Chinese rural migrants are rare. The temporary nature of Chinese rural–urban migration has been well documented in many studies, in which rural migrants are often referred to as "floating population" (Goodkind and West, 2002; Zhu, 2007). Studies on Chinese migrant workers stress the restrictions of the *hukou* system that constrain rural migrants' occupational choices (Meng and Zhang, 2001; Zhang, 2010), limit their access to social benefits and education resources that urban residents enjoy (Afridi and Li, 1979; Song, 2014; Wang and Zuo, 1999) and make it difficult for them to settle down in destination cities (Fan, 2011; Hu et al., 2011; Wu, 2006; Zhan, 2011; Zhu, 2007). Only the papers of Hare (1999) and Démurger and Xu (2015) directly address the duration of rural–urban migration in China, using the duration model. However, they modelled migration as a one-spell process rather than as recurrent events with multiple spells, and their data were obtained from only one county they surveyed.

To our knowledge, no paper considers Chinese repeat migration from the perspective of recurrent events, which is the gap we try to fulfil. We contribute to the literature in two ways. First, we use a recurrent-event duration model for repeat migration. Second, we use a new data source from a survey covering nine cities in East China. The survey records the length of stay in each destination city in one's migration history as well as other related information, making it possible to estimate the recurrent-event duration model.

Data source and sample description

Data source

The data source is a survey conducted by our research team. Survey questions cover a wide range of issues related to migrant workers' working and living conditions in destination cities. Importantly, one survey section consists of questions regarding one's migration history, including the names of all destination cities, the length of stay in each city, whether one migrated to a city alone or with family members and a measure of the relative distance from a place of destination to one's place of origin.

Survey data were collected in nine cities in East and Middle China from 2010 to 2012. The nine cities include Beijing, Dongguan, Wenzhou, Qingdao, Wuxi, Shenyang, Zhengzhou, Wuhan and Changsha, which are the centres of important megalopolises in China.[1] These cities are at different administrative levels, including a centrally directed municipality, four provincial capitals and four prefecture-level cities. In each city, we spent 10 days in collecting answers. Table 1 shows the specific survey time and the numbers of effective respondents in the nine cities.

Targeted respondents are migrants who came from rural areas and lived outside their places of origin for more than half a year. Migrant workers' high degree of mobility in terms of their workplaces and residences posed a challenge for collecting data. To ensure representativeness, we included both city communities and specialized industrial zones (that is, industrial parks as well as economic and technological development

Table 1. *Descriptions of the nine Chinese cities in the survey.*

City	Province	Administrative level	Survey date	No. of respondents
Beijing	Beijing	Municipality	03/2010	319
Wenzhou	Zhejiang	Prefectural city	03/2010	266
Dongguan	Guangdong	Prefectural city	04/2010	295
Qingdao	Shandong	Prefectural city	04/2010	387
Wuxi	Jiangsu	Prefectural city	09/2011	236
Shenyang	Liaoning	Provincial capital	10/2011	203
Zhengzhou	Henan	Provincial capital	07/2012	234
Wuhan	Hubei	Provincial capital	07/2012	203
Changsha	Hunan	Provincial capital	08/2012	226

Source: authors' survey.

zones) at a 2:1 ratio.[2] In city communities, surveyors randomly selected and visited residential addresses to let migrant workers living there answer survey questions. In specialised industrial zones, enterprises were randomly selected. Surveyors visited the selected enterprises and recruited survey participants. In addition, the sample structure was controlled according to the industrial structure in each city. The profile of migrant workers in the sample is very similar to the information on migrant populations in the 2010 national population census.[3]

Sample description

We selected samples from all respondents who met the following condition: the first year of outmigration from one's place of origin should not be prior to 1990 and no later than 2010. This sets the time window of the duration analysis to be from 1990 to 2012.[4] After selecting samples with this condition and removing samples with missing values, the number of sample migrants in subsequent analyses is 2163, accounting for 4054 person-time records of migration.[5]

We further divide the sample into three groups: the low-, medium- and high-frequency groups, according to the number of times that a migrant has ever changed destination cities. The low-frequency group consists of migrants who had moved at least once and at most twice by the date of the survey. The medium-frequency group consists of those who had moved three to four times. The high-frequency group consists of those who had moved at least five times. The maximum number of migration times is set to be eight due to the limitation of the table in the survey asking for migration history.

We expect the three groups to display different migration patterns. The low-frequency group mainly has young inexperienced migrants, while the medium- and high-frequency groups have more experienced migrants. DaVanzo (1983) pointed out that, as the number of migration episodes increases, migrants gain experience, which should reduce information costs, and, thus, facilitate searches for a new location. However, as a migrant stays in one destination longer, his/her attachment to local specific capital will deepen. Personal and household attributes, such as age, gender, education and marriage status, may also exhibit variation among the three groups, leading to different spatial mobility.

Table 2 presents descriptive statistics regarding personal characteristics and other variables that will be used as time-independent variables in the recurrent-event duration model. We summarise the following facts from the descriptive statistics:

- *Number of observations*. The majority of migrants (77% of the full sample) are persons belonging to the low-frequency group, and only a small number of migrants are in

Table 2. *Descriptive statistics of personal characteristics of repeat migrants.*

	Full sample	Low frequency	Medium frequency	High frequency
No. of person-time records	4054	2301	1385	368
No. of individuals	2163	1676	421	66
Age				
Age when surveyed	29 (9.79)	29 (10.01)	30 (8.78)	33 (9.48)
Age of first migration	23 (8.41)	24 (8.76)	21 (6.65)	21 (7.12)
Gender				
Female	878 (40.59)	738 (44.03)	134 (31.83)	6 (9.09)
Male	1285 (59.41)	938 (55.97)	287 (68.17)	60 (90.91)
Education				
Elementary School	226 (10.45)	158 (9.43)	58 (13.78)	10 (15.15)
Middle school	811 (37.49)	599 (35.74)	180 (42.76)	32 (48.48)
High school	633 (29.26)	485 (28.94)	128 (30.4)	20 (30.3)
Associate degree	257 (11.88)	222 (13.25)	32 (7.6)	3 (4.55)
Bachelor and above	236 (10.91)	212 (12.65)	23 (5.46)	1 (1.52)
Hukou				
Urban	458 (21.17)	393 (23.45)	55 (13.06)	10 (15.15)
Rural	1705 (78.83)	1283 (76.55)	366 (86.94)	56 (84.85)
Farmland				
Not own	1054 (48.73)	853 (50.89)	175 (41.57)	26 (39.39)
Own	1109 (51.27)	823 (49.11)	246 (58.43)	40 (60.61)
Social network				
Not consider	1234 (57.05)	954 (56.92)	248 (58.91)	32 (48.48)
Consider	929 (42.95)	722 (43.08)	173 (41.09)	34 (51.52)
Region of origin				
East	753 (34.81)	615 (36.69)	123 (29.22)	15 (22.73)
West	324 (14.98)	234 (13.96)	71 (16.86)	19 (28.79)
Middle	1086 (50.21)	827 (49.34)	227 (53.92)	32 (48.48)

Notes: For age and age of first migration, the numbers in a cell are in the format of “mean (standard deviation)”. For the variables below age, the numbers are in the format of “counts (proportion)”.
Source: Calculation from authors’ survey data.

the high-frequency group. In contrast, only 57% of person-time records of migration come from the low-frequency group, which is reasonable since migrants in the other groups moved more than twice.

- *Age and the age of the first migration*. The average age of all sample migrants on the survey is 29. On average, the medium- and high-frequency groups are older than the low-frequency group. In contrast, migrants in the medium- and high-frequency groups started their first migration at a younger age compared with the low-frequency group.
- *Gender*. Male migrants account for more than half of the full sample, and the proportions of female migrants in the medium- and high-frequency groups are noticeably smaller than in the low-frequency group.
- *Education*. The proportion of migrants who have education level at high school or less is higher in the medium- and high-frequency groups than in the low-frequency group, whereas the proportion of migrants with college education is lower in the medium- and high-frequency groups.
- *Hukou*. People with urban *hukou* tend to migrate less than those with rural *hukou*, which to some extent reflects the restriction of *hukou* on migrants’ settlement in destination cities.
- *Farmland*. The proportion of migrants who own farmland at home is much higher than

those who do not in the medium- and high-frequency group, while such difference is small in the low-frequency group.

- *Social network*. When asked about whether the existence of social network is an important consideration for one's migration decision, more than 40% of respondents report that they consider this factor. The proportion is slightly higher than 50% in the high-frequency group.
- *Region of origin*. More than half of the sample migrants are from Western China. The proportion of migrants whose region of origin is Eastern China decreases moving from the low- to the high-frequency group.

Table 3 shows descriptive statistics of migration history. All variables in this table will be used in the recurrent-event duration analysis as time-dependent variables. The summaries of descriptive statistics are as follows:

- *Migration times*. From the low- to the high-frequency group, the number of repeat migrations increases.
- *Total and average duration*. From the low- to the high-frequency group, total duration staying in all destinations increases, while the average duration in each city decreases.
- *Being alone*. When asked whether they worked in a city alone or accompanied by some family members, more than 60% of migrants reported to have moved by themselves. For the medium- and high-frequency groups, the proportions of migrants moving alone are higher.
- *The "city-type" distance*. Instead of using distance in geographic space to measure how far it is from the places of origin to destination, we use a relative measure of distance—a categorical variable describing four types of migration: (i) moving to a different township

Table 3. *Descriptive statistics of migration history of repeat migrants.*

	Full sample	Low frequency	Medium frequency	High frequency
No. of migration times	1.87 (1.11)	1.37 (0.48)	3.29 (0.45)	5.58 (0.79)
Total duration	59.31 (54.19)	53.65 (51.6)	75.07 (57.09)	102.72 (60.51)
Average duration	38.25 (42.05)	42.85 (45.88)	23.04 (17.67)	18.61 (11.28)
Being alone				
Yes	2820 (69.56)	1511 (65.67)	1019 (73.57)	290 (78.8)
No	1234 (30.44)	790 (34.33)	366 (26.43)	78 (21.2)
Distance				
Move to another township	54 (1.33)	23 (1.0)	25 (1.81)	6 (1.63)
Move to another county	164 (4.05)	92 (4.0)	57 (4.12)	15 (4.08)
Move to another city	1298 (32.02)	881 (38.29)	364 (26.28)	53 (14.4)
Move to another province	2538 (62.6)	1305 (56.71)	939 (67.8)	294 (79.89)
City scale				
Super city	1148 (28.32)	682 (29.64)	369 (26.64)	97 (26.36)
Huge city	1159 (28.59)	688 (29.9)	382 (27.58)	89 (24.18)
Large city	608 (15)	279 (12.13)	264 (19.06)	65 (17.66)
Medium-sized city	754 (18.6)	415 (18.04)	262 (18.92)	77 (20.92)
Small city	214 (5.28)	142 (6.17)	53 (3.83)	19 (5.16)
County seat	171 (4.22)	95 (4.13)	55 (3.97)	21 (5.71)
Destination region				
East	2989 (73.73)	1733 (75.32)	1013 (73.14)	243 (66.03)
West	161 (3.97)	46 (2.0)	72 (5.2)	43 (11.68)
Middle	904 (22.3)	522 (22.69)	300 (21.66)	82 (22.28)

Notes: For the number of migration times, total length of duration and average length of duration, the numbers in a cell are in the format of "mean (standard deviation)". For the rest of variables, the numbers are in the format of "counts (proportion)".
Source: Calculation from authors' survey data.

within the county of origin, (ii) moving to a different county within the city of origin, (iii) moving to a different city within the province of origin and (iv) moving to a different province. This variable not only measures the relative distance in space but also captures migrants' psychological distance to host cities. As shown in Table 3, over half of the sample migrants moved outside of their origin provinces. Low-frequency migrants tend to move more to other cities in the origin provinces than do medium- and high-frequency migrants, while high-frequency migrants are more likely to move to other provinces.

- *City scale*. This categorical variable classifies Chinese cities into six categories according to the size of population: super cities, huge cities, large cities, medium-sized cities, small cities and county seats. More than half of sample migrants moved to super and huge cities. However, the proportions of migrants in super and huge cities in the medium- and high-frequency groups are lower than that in the low-frequency group.
- *Region of destination*. The majority of migrants in the sample chose the eastern region as their destination, while many high-frequency migrants also moved to the western region.

Model specification

We estimate a recurrent-event duration model to examine the effects of explanatory variables, including both time-independent and time-dependent variables, on the migration duration in each destination city in which a migrant has worked. Duration models are widely used in economics for topics of unemployment, strikes, marriage, migration and so on (van den Berg, 2001). In the terminology of the duration model, the event in our research is defined as moving from one city to another. The random variable T is the length of stay in a city, and t is its realization. The hazard function, $h(t)$, gives the instantaneous probability of an event occurring, given that the previous state has lasted up to time t:

$$h(t) = \lim_{\Delta t \to 0} \frac{Pr\left(t \le T \le t + \Delta t \,|\, T \ge t\right)}{\Delta t} \qquad (1)$$

We use the Cox PH model with the gap-time approach to estimating the model.[6] The Cox PH model is relatively easy to use for recurrent events, compared with the parametric models, such as the Weibull model. The gap-time approach is one of the three commonly used approaches to estimate the recurrent-event duration model in terms of how to handle the starting and ending time and the length of duration between two consecutive events. Box-Steffensmeier et al. (2004) advocate using the gap-time approach in analyses for which the length of a spell between two consecutive events and the ordering of events is important, while the exact time of when an event starts and ends is not. This fits our research because our survey does not record the exact time of moving into a city. Also, the model is estimated with the robust method to account for correlation of sequential events for the same person. The Cox PH model with stratification is as follows:

$$h_k\left(t, \mathbf{x}_{kj}\right) = h_{0k}\left(t\right)\exp\left(\beta' \mathbf{x}_{kj}\right) \qquad (2)$$

where $\mathbf{x}_{kj}$ is the vector of explanatory variables for individual j at the kth event, and β is the corresponding vector of coefficients. The subscript, k, which is the stratification variable, indicates that explanatory variables can be time dependent, meaning that their values can change at each stage of migration. $h_{0k}(t)$ is the baseline hazard function for the kth event. The fact that $h_{0k}(t)$ does not depend on individual j is a requirement of the PH assumption. Since we estimate a recurrent-event Cox PH duration model, $h_{0k}(t)$ can change its value at different stages ($k = 1, 2, \ldots$) of migration.

The duration model is capable of handling the right-censoring problem, which is the case for our data. At the time of being surveyed, migrant workers were in their last destination cities, and the event, migrating for another time, had not happened yet. Thus, their true durations in their last destination were unobservable, which is called right-censored observations. With the recurrent-event duration model, we can use a censoring indicator variable to denote all previously completed migrations (uncensored observations) as one and the current migration stage (censored observations) as zero. The censoring indicator variable enters the partial likelihood estimation for a Cox PH model to account for right censoring.

Explanatory variables include most of the variables shown in Tables 2 and 3, representing time-independent and time-dependent variables, respectively. While the variables in Table 2 are considered as being time independent, some caveats are added. The three variables concerning education, *hukou* status and farmland ownership could change at some stage of migration. Migrants may finish their education outside hometowns, and may change rural *hukou* to urban *hukou* in a certain city, and their land ownership could also be changed at some point. Since we cannot pinpoint when such changes occur, however, we assume these variables to be time independent. We should be cautious when interpreting the estimation results for these variables.

Estimation results

We estimate the recurrent-event duration model with two different sets of explanatory variables. The differences between the two sets lie in how to specify the dummy variables for education and for the origin and destination regions. The baseline specification uses a dummy variable for education to indicate whether a migrant has achieved college-equivalent education level and uses dummy variables for each origin region and each destination region. The alternative specification uses dummy variables for the detailed education levels from elementary school to college and uses dummy variables for each origin–destination pair to reveal the direction of migration flows. The estimated coefficients $(\hat{\beta})$ for the baseline specification along with standard deviations are reported in Table 4. The corresponding hazard ratios, given by $\exp(\hat{\beta})$, are reported in Table 5. The results for the alternative specification are reported in Tables 6 and 7. We estimate the model with the whole sample, the low-frequency group and the medium-frequency group, with the results reported in Columns 1 to 3 in Tables 4 to 7. Since the number of observations in the high-frequency group is so small, especially for the variable of higher education, the results estimated with this group alone may not be reliable. So we run the model with the medium- and high-frequency groups combined, with the results reported in Column 4 in these tables.

We can interpret the estimated coefficients in a Cox PH model in the following way. A positive coefficient in Tables 4 and 6 corresponds to a hazard ratio greater than one in Tables 5 and 7, indicating that, holding other variables constant, an increase in one variable will make the event, which is migrating to another city, more likely to happen, or in other words, make the duration of staying in the current location potentially shorter. For instance, as for gender, our results show little difference in the potential of moving again between the males and the female. An exception occurs in the medium-frequency group, with the estimated coefficient for male migrants being significantly negative. It ranges from −0.15 to −0.14, with hazard ratios of 0.86 to 0.87. This means that, among the medium-frequency migrants, controlling for other things, the potential of repeat migration for male migrants is 13% to 14% lower than for the female.

For time-independent variables, which mostly concern demographic characteristics of migrant workers, our results confirm the previous findings that repeat migrants are usually young,

Table 4. *The results of estimation for the baseline specification.*

	Dependent variable: hazard function $h(t)$			
	(1) Whole sample	(2) Low frequency	(3) Medium frequency	(4) Medium and high frequency combined
Time-independent variables				
Gender: male	0.074	–0.007	–0.150*	–0.100
	(0.055)	(0.086)	(0.083)	(0.075)
Higher education: yes	–0.100	0.068	–0.260*	0.180
	(0.082)	(0.110)	(0.130)	(0.130)
Rural *hukou*: yes	0.330***	0.460***	0.200	0.200*
	(0.081)	(0.120)	(0.140)	(0.120)
Own farmland: yes	–0.067	–0.190**	–0.021	–0.082
	(0.054)	(0.092)	(0.078)	(0.074)
Age of first migration	–0.023***	–0.032***	–0.009	–0.007
	(0.004)	(0.006)	(0.005)	(0.006)
Consider social network: yes	0.064	0.065	0.031	0.094
	(0.050)	(0.083)	(0.077)	(0.067)
Time-dependent variables				
Migrating alone: no	–0.790***	–0.870***	–0.340***	–0.400***
	(0.063)	(0.100)	(0.078)	(0.072)
Distance: move to another county	–0.220	–0.380	–0.170	–0.041
	(0.200)	(0.310)	(0.300)	(0.260)
Distance: move to another city	–0.770***	–0.860***	–0.180	–0.063
	(0.180)	(0.280)	(0.270)	(0.230)
Distance: move to another province	–0.290*	–0.560**	–0.071	0.150
	(0.170)	(0.280)	(0.280)	(0.230)
City size: huge	–0.074	–0.130	0.040	0.030
	(0.070)	(0.130)	(0.095)	(0.082)
City size: large	0.430***	0.710***	0.014	0.083
	(0.067)	(0.110)	(0.095)	(0.083)
City size: medium	0.011	0.190	0.089	0.078
	(0.070)	(0.130)	(0.099)	(0.086)
City size: small	–0.130	0.037	–0.120	0.082
	(0.110)	(0.200)	(0.180)	(0.160)
City size: county seat	0.130	0.045	0.360*	0.420***
	(0.130)	(0.210)	(0.190)	(0.160)
Region of origin: west	–0.130	–0.270*	–0.170	–0.160
	(0.089)	(0.150)	(0.130)	(0.110)
Region of origin: middle	–0.017	0.150	–0.190*	–0.210**
	(0.067)	(0.120)	(0.100)	(0.083)
Region of destination: west	0.800***	1.200***	0.250*	0.290***
	(0.090)	(0.160)	(0.130)	(0.110)
Region of destination: middle	0.039	0.083	–0.028	0.003
	(0.077)	(0.140)	(0.120)	(0.091)
Observations	4,054	2,301	1,385	1,753
Log likelihood	–11,859.0	–4064.0	–4864.0	–6429.0
Wald test (df = 19)	579.0***	354.0***	51.0***	70.0***
Score (logrank) test (df = 19)	623.0***	321.0***	48.0***	71.0***

Notes: (1) *$P < 0.1$; **$P < 0.05$; ***$P < 0.01$. (2) Standard deviations are reported in parentheses.
Source: Calculation from authors' survey data.

Table 5. *The hazard ratios associated with the coefficients in Table 4.*

	Dependent variable: hazard function $h(t)$			
	(1) Whole sample	(2) Low frequency	(3) Medium frequency	(4) Medium and high frequency combined
Time-independent variables				
Gender: male	1.100	0.990	0.860*	0.900
	(0.970, 1.200)	(0.840, 1.200)	(0.730, 1.000)	(0.780, 1.000)
Higher education: yes	0.900	1.100	1.300*	1.200
	(0.770, 1.100)	(0.860, 1.300)	(1.000, 1.700)	(0.930, 1.500)
Rural *hukou*: yes	1.400***	1.600***	1.200	1.200*
	(1.200, 1.600)	(1.200, 2.000)	(0.930, 1.600)	(0.970, 1.500)
Own farmland: yes	0.940	0.830**	0.980	0.920
	(0.840, 1.000)	(0.690, 0.990)	(0.840, 1.100)	(0.800, 1.100)
Age of first migration	0.980***	0.970***	0.990	0.990
	(0.970, 0.990)	(0.960, 0.980)	(0.980, 1.000)	(0.980, 1.000)
Consider social network: yes	1.100	1.100	1.000	1.100
	(0.970, 1.200)	(0.910, 1.300)	(0.890, 1.200)	(0.960, 1.300)
Time-dependent variables				
Migrating alone: no	0.450***	0.420***	0.710***	0.670***
	(0.400, 0.510)	(0.340, 0.510)	(0.610, 0.830)	(0.580, 0.770)
Distance: move to another county	0.800	0.690	0.840	0.960
	(0.550, 1.200)	(0.370, 1.300)	(0.460, 1.500)	(0.580, 1.600)
Distance: move to another city	0.460***	0.420***	0.830	0.940
	(0.330, 0.660)	(0.240, 0.740)	(0.490, 1.400)	(0.590, 1.500)
Distance: move to another province	0.740*	0.570**	0.930	1.200
	(0.530, 1.000)	(0.330, 0.980)	(0.540, 1.600)	(0.730, 1.800)
City size: huge	0.930	0.880	1.000	1.000
	(0.810, 1.100)	(0.680, 1.100)	(0.860, 1.300)	(0.880, 1.200)
City size: large	1.500***	2.000***	1.000	1.100
	(1.400, 1.800)	(1.600, 2.500)	(0.840, 1.200)	(0.920, 1.300)
City size: medium	1.000	1.200	1.100	1.100
	(0.880, 1.200)	(0.930, 1.600)	(0.900, 1.300)	(0.910, 1.300)
City size: small	0.880	1.000	0.890	1.100
	(0.700, 1.100)	(0.700, 1.500)	(0.630, 1.300)	(0.790, 1.500)
City size: county seat	1.100	1.000	1.400*	1.500***
	(0.880, 1.500)	(0.690, 1.600)	(0.980, 2.100)	(1.100, 2.100)
Region of origin: west	0.880	0.760*	0.840	0.850
	(0.740, 1.000)	(0.570, 1.000)	(0.650, 1.100)	(0.690, 1.100)
Region of origin: middle	0.980	1.200	0.820*	0.810**
	(0.860, 1.100)	(0.930, 1.500)	(0.680, 1.000)	(0.690, 0.960)
Region of destination: west	2.200***	3.300***	1.300*	1.300***
	(1.900, 2.700)	(2.400, 4.600)	(0.990, 1.700)	(1.100, 1.600)
Region of destination: middel	1.000	1.100	0.970	1.000
	(0.890, 1.200)	(0.830, 1.400)	(0.770, 1.200)	(0.840, 1.200)
Observations	4054	2301	1385	1753

Notes: (1) $*P < 0.1$; $**P < 0.05$; $***P < 0.01$. (2) The hazard ratios are computed as $\exp(\hat{\beta})$. (3) The confidential intervals for the hazard ratios are reported in parentheses.
Source: Calculation from authors' survey data.

Table 6. *The results of estimation for the alternative specification.*

	Dependent variable: hazard function $h(t)$			
	(1) Whole sample	(2) Low frequency	(3) Medium frequency	(4) Medium and high frequency combined
Time-independent variables				
Gender: male	0.078 (0.055)	0.002 (0.086)	−0.140* (0.083)	−0.083 (0.076)
Education: middle school	−0.064 (0.081)	−0.050 (0.170)	0.120 (0.120)	0.110 (0.097)
Education: high school	0.011 (0.085)	0.130 (0.170)	0.310** (0.130)	0.300*** (0.110)
Education: associate degree	−0.045 (0.120)	0.180 (0.200)	0.430** (0.200)	0.440** (0.180)
Education: bachelor and above	−0.240* (0.130)	0.030 (0.220)	0.490** (0.220)	0.260 (0.190)
Rural *hukou*: yes	0.340*** (0.081)	0.460*** (0.120)	0.230 (0.140)	0.240** (0.120)
Own farmland: yes	−0.067 (0.054)	−0.170* (0.091)	−0.020 (0.077)	−0.090 (0.074)
Age of first migration	−0.023*** (0.004)	−0.031*** (0.006)	−0.007 (0.006)	−0.004 (0.006)
Consider social network: yes	0.065 (0.050)	0.076 (0.085)	0.054 (0.078)	0.110* (0.067)
Time-dependent variables				
Migrating alone: no	−0.790*** (0.063)	−0.880*** (0.100)	−0.330*** (0.077)	−0.390*** (0.072)
Distance: move to another county	−0.190 (0.200)	−0.350 (0.320)	−0.260 (0.290)	−0.110 (0.250)
Distance: move to another city	−0.750*** (0.180)	−0.830*** (0.290)	−0.250 (0.260)	−0.120 (0.230)
Distance: move to another province	−0.290 (0.180)	−0.520* (0.290)	−0.069 (0.270)	0.160 (0.230)
City size: huge	−0.085 (0.070)	−0.140 (0.130)	0.059 (0.092)	0.043 (0.080)
City size: large	0.430*** (0.067)	0.710*** (0.120)	0.002 (0.096)	0.071 (0.084)
City size: medium	−0.00001 (0.071)	0.170 (0.130)	0.065 (0.100)	0.056 (0.088)
City size: small	−0.140 (0.120)	0.023 (0.210)	−0.170 (0.180)	0.061 (0.160)
City size: county seat	0.120 (0.130)	0.071 (0.200)	0.350* (0.200)	0.400** (0.170)
East to west	0.810*** (0.190)	3.100*** (0.210)	−0.079 (0.270)	−0.130 (0.200)
East to middle	0.077 (0.200)	−0.110 (0.410)	−0.095 (0.360)	−0.100 (0.250)
West to east	−0.150 (0.100)	−0.400** (0.180)	−0.210 (0.160)	−0.220* (0.130)
West to west	0.760*** (0.130)	1.100*** (0.220)	0.230* (0.140)	0.260* (0.130)
West to middle	−0.004 (0.230)	0.074 (0.470)	−0.440 (0.270)	−0.190 (0.230)

Table 6. *Continued*

	Dependent variable: hazard function $h(t)$			
	(1) Whole sample	(2) Low frequency	(3) Medium frequency	(4) Medium and high frequency combined
Middle to east	0.005	0.160	−0.240**	−0.260***
	(0.077)	(0.130)	(0.100)	(0.092)
Middle to west	0.710***	0.960***	−0.110	0.033
	(0.150)	(0.190)	(0.270)	(0.210)
Middle to middle	0.007	0.230*	−0.210*	−0.210**
	(0.079)	(0.130)	(0.120)	(0.100)
Observations	4,054	2,301	1,385	1,753
Log likelihood	−11,856.0	−4,059.0	−4,858.0	−6,420.0
Wald test (df = 26)	608.0***	1,025.0***	67.0***	88.0***
Score (logrank) test (df = 26)	628.0***	336.0***	60.0***	89.0***

Notes: (1) *$P < 0.1$; **$P < 0.05$; ***$P < 0.01$. (2) Standard deviations are reported in parentheses.
Source: Calculation from authors' survey data.

well educated and skilful (Constant et al., 2013; DaVanzo, 1983; Newbold and Cicchino, 2007). The age of first migration has significantly negative coefficients for the full sample and the low-frequency group. Young migrants, when they first move to the outside world, are usually less experienced and possess less location-specific capital so that they are more likely to migrate for a second time as a "corrective" move (DaVanzo, 1981). Migrants with education higher than high school show greater spatial mobility in the medium-frequency group and the combined group, with the coefficients being significantly positive. But the coefficient on bachelor's degree is significantly negative in the full sample estimation. The contradicting sign of the coefficients on higher education may reflect heterogeneous migration patterns. But it may also be caused by some estimation problem, such as the violation of the PH assumption, which will be explained shortly. Consistent with other research concerning the *hukou* system in China, the coefficients on rural *hukou* are highly significant and positive, implying that, compared with urban residents, *hukou* restrictions are obstacles for rural migrants to stay for a long time and settle down in cities. The variable of whether a rural migrant owns farmland has significantly negative coefficients for the low-frequency groups, implying that owning farmland may provide migrants certain forms of support to survive and stay longer in the much more competitive environment in the host cities. Finally, whether migrant workers consider the presence of relatives or some social network as a factor in their migration decisions does not influence the duration of stay in each destination city. It may reflect our data in which, as shown in Table 2, more than half of the respondents did not choose social network in a targeting city as an important factor in their consideration.

A correct interpretation of the coefficients on the time-independent variables in a Cox PH model hinges on the PH assumption. Since our model is a recurrent-event model stratified by the time of migration, k, the PH assumption requires that the hazard ratio, $h_k(t, \mathbf{x}_k)/h_k(t, \mathbf{x}_k^*)$, should be constant over time, t, within the kth stratum for any time-invariant $\mathbf{x}_k$ and $\mathbf{x}_k^*$. We test the proportionality assumption with the scaled Schoenfeld residuals.[7] Tables A1 and A2 contain the test results for both the baseline and the alternative model specifications.[8] In most cases, the proportionality assumption holds. However, high school and associate education, owning farmland and *hukou* status do not satisfy the assumption at the 5% significance level at the third and fourth strata. One possible explanation

Table 7. *The hazard ratios associated with the coefficients in Table 6.*

	Dependent variable: hazard function $h(t)$			
	(1) Whole sample	(2) Low frequency	(3) Medium frequency	(4) Medium and high frequency combined
Time-independent variables				
Gender: male	1.100	1.000	0.870*	0.920
	(0.970, 1.200)	(0.850, 1.200)	(0.740, 1.000)	(0.790, 1.100)
Education: middle school	0.940	0.950	1.100	1.100
	(0.800, 1.100)	(0.680, 1.300)	(0.890, 1.400)	(0.920, 1.400)
Education: high school	1.000	1.100	1.400**	1.400***
	(0.860, 1.200)	(0.810, 1.600)	(1.000, 1.800)	(1.100, 1.700)
Education: associate degree	0.960	1.200	1.500**	1.600**
	(0.760, 1.200)	(0.800, 1.800)	(1.000, 2.300)	(1.100, 2.200)
Education: bachelor and above	0.790*	1.000	1.600**	1.300
	(0.610, 1.000)	(0.660, 1.600)	(1.100, 2.500)	(0.890, 1.900)
Rural *hukou*: yes	1.400***	1.600***	1.300	1.300**
	(1.200, 1.600)	(1.200, 2.000)	(0.950, 1.700)	(1.000, 1.600)
Own farmland: yes	0.940	0.840*	0.980	0.910
	(0.840, 1.000)	(0.700, 1.000)	(0.840, 1.100)	(0.790, 1.100)
Age of first migration	0.980***	0.970***	0.990	1.000
	(0.970, 0.990)	(0.960, 0.980)	(0.980, 1.000)	(0.980, 1.000)
Consider social network: yes	1.100	1.100	1.100	1.100*
	(0.970, 1.200)	(0.910, 1.300)	(0.910, 1.200)	(0.980, 1.300)
Time-dependent variables				
Migrating alone: no	0.460***	0.410***	0.720***	0.680***
	(0.400, 0.520)	(0.340, 0.510)	(0.620, 0.840)	(0.590, 0.780)
Distance: move to another county	0.820	0.700	0.770	0.900
	(0.560, 1.200)	(0.380, 1.300)	(0.430, 1.400)	(0.550, 1.500)
Distance: move to another city	0.470***	0.430***	0.780	0.890
	(0.330, 0.680)	(0.250, 0.760)	(0.470, 1.300)	(0.570, 1.400)
Distance: move to another province	0.750	0.590*	0.930	1.200
	(0.530, 1.100)	(0.340, 1.000)	(0.550, 1.600)	(0.750, 1.800)
City size: huge	0.920	0.870	1.100	1.000
	(0.800, 1.100)	(0.670, 1.100)	(0.890, 1.300)	(0.890, 1.200)
City size: large	1.500***	2.000***	1.000	1.100
	(1.300, 1.800)	(1.600, 2.500)	(0.830, 1.200)	(0.910, 1.300)
City size: medium	1.000	1.200	1.100	1.100
	(0.870, 1.100)	(0.920, 1.500)	(0.880, 1.300)	(0.890, 1.300)
City size: small	0.870	1.000	0.840	1.100
	(0.700, 1.100)	(0.680, 1.500)	(0.590, 1.200)	(0.780, 1.400)
City size: county seat	1.100	1.100	1.400*	1.500**
	(0.870, 1.500)	(0.720, 1.600)	(0.950, 2.100)	(1.100, 2.100)
East to west	2.300***	22.000***	0.920	0.880
	(1.600, 3.300)	(15.000, 33.000)	(0.540, 1.600)	(0.590, 1.300)
East to middle	1.100	0.900	0.910	0.900
	(0.730, 1.600)	(0.400, 2.000)	(0.450, 1.800)	(0.550, 1.500)
West to east	0.860	0.670**	0.810	0.800*
	(0.700, 1.100)	(0.470, 0.960)	(0.600, 1.100)	(0.620, 1.000)
West to west	2.100***	3.100***	1.300*	1.300*
	(1.700, 2.700)	(2.000, 4.800)	(0.960, 1.700)	(1.000, 1.700)
West to middle	1.000	1.100	0.650	0.820
	(0.640, 1.600)	(0.420, 2.700)	(0.380, 1.100)	(0.530, 1.300)

Table 7. *Continued*

	Dependent variable: hazard function $h(t)$			
	(1) Whole sample	(2) Low frequency	(3) Medium frequency	(4) Medium and high frequency combined
Middle to east	1.000	1.200	0.780**	0.770***
	(0.860, 1.200)	(0.900, 1.500)	(0.640, 0.960)	(0.640, 0.920)
Middle to west	2.000***	2.600***	0.890	1.000
	(1.500, 2.700)	(1.800, 3.800)	(0.530, 1.500)	(0.680, 1.600)
Middle to middle	1.000	1.300*	0.810*	0.810**
	(0.860, 1.200)	(0.980, 1.600)	(0.640, 1.000)	(0.660, 0.990)
Observations	4054	2301	1385	1753

Notes: (1) $*P < 0.1$; $**P < 0.05$; $***P < 0.01$. (2) The hazard ratios are computed as $\exp(\hat{\beta})$. (3) The confidential intervals for the hazard ratios are reported in parentheses.
Source: Calculation from authors' survey data.

is that these variables may change their values at some stage of one's migration history. Given that these are fundamental variables that satisfy the proportionality assumption in some cases, we still include them in estimation.

Time-dependent variables are not required to satisfy the PH assumption, whose estimated coefficients convey some interesting findings. First, the variable representing migrants accompanied by family members has significantly negative coefficients in most cases. That is, compared with migrants who move alone, the companionship of family members makes migrants less likely to move from the current city. Second, among different "city-type" distances, moving to another city within the home province and moving to another province have significantly negative effects on the hazard of moving again in the whole sample and the low-frequency group. Possibly, moving to places where migrants are not familiar may incur considerable costs in settling down, searching for jobs and adapting to the host environment. This may make migrants reluctant to move again in a short period, hoping to earn more to compensate the searching costs. As for the city scale, compared with super cities, such as Beijing, Shanghai and Guangzhou, large cities, mostly prefecture-level and third-tier cities, may have less attractiveness to retain migrant workers. To some extent, this suggests that despite high living costs, super cities still possess strong centripetal forces for migrants (Xing and Zhang, 2013). Finally, regarding the direction of migration flows, the west-to-east migration exhibits greater duration than other directions since the coefficients on other origin–destination pairs are significantly positive or insignificant.

Conclusion

This article focuses on repeat migration, specifically intercity movements of migrants in China after their initial migration. In terms of methodology, our contribution is that we estimate a recurrent-event duration model, which is still rare in the literature, and we use a unique first-hand survey that enables us to carry out the model estimation. The overall outcomes of our model estimation are satisfactory. We confirm that some personal characteristics, such as age of first migration, have significant effects on the potential of repeat migration, whereas gender and social networks have little effect. While we find that higher education, *hukou* status and owning farmland in home villages have significant coefficients on the hazard of repeat migration, we call for caution in interpreting their effects because these variables violate the PH assumption for some subsets of the sample. The time-dependent variables tell us more about the effect of one's migration history. Migrants prefer staying in super cities compared with large and small cities. The eastern region of China is the most attractive region for migrants. The presence of family members during one's migration period may make migrants more likely to stay longer in the current host cities.

The results of the recurrent-event model also have important policy implications. First, in the last 3 years, the Chinese central government put forward some policies of relaxing *hukou* registration in the second- and third-tier cities but maintaining strict *hukou* control over super cities. The purpose of these policies are two-fold: promoting urbanization for less developed cities and preventing oversizing of super cities. Our results show that migrant workers still tend to stay in super cities longer than they do in second- and third-tier cities, reflecting the lasting agglomeration forces from super cities. Thus, current policies may not be able to fulfil the government's expectation in the near future. Second, we find that migrants receive strong support from family members when they can move and live in a city together. However, lack of access to education for their children, deficient public healthcare coverage and prohibitive housing prices make it difficult for migrant workers to settle in cities, let alone their family members. The government should devote more attention to concerns relating to the family issues of migrant workers.

Endnotes

[1] See Figure A1 in the appendix for the locations of the nine Chinese cities being surveyed, which belong to eight megalopolises: Beijing–Tianjin–Hebei, Pearl–River–Delta, Yangtze–River–Delta, Shandong–Penisular, Central–Liaoning, Central–Plain, Middle–Yangtze–River and Greater–Changsha.

[2] According to the National Bureau of Statistics of China (2014), 35.5% of migrant workers worked and lived in the specialised industrial zones in 2013 and the rest worked and lived in other parts of urban areas, referred to as "city communities". To be consistent with this general pattern, we sampled migrant workers from specialised industrial zones and city communities at a ratio of 1:2.

[3] The 2011 National Bureau of Statistics of China Tabulation from the 2010 China Population Census.

[4] The year 1990 was chosen as the starting year of the analysis because, as Meng (2012) points out, rural labour began to migrate into cities in great magnitude with less government restrictions in the 1990s.

[5] We also exclude 12 respondents who identified themselves as local residents. By doing so, we attempt to avoid the cases of return migration since our primary interest is in onward, not return, migration. Admittedly, we cannot exclude another type of return migration, those returning to previously inhabited locations besides the place of origin, due to the lack of relevant information.

[6] Our main reference for the Cox PH model is Chapter 8 in Kleinbaum and Klein (2011) for an introduction to recurrent-event survival analysis.

[7] See Chapter 8 in Box-Steffensmeier et al. (2004) for a survey of the tests for the PH assumption. Huang et al. (2011) is the only paper we have found that proposes a method for testing the proportionality assumption in a recurrent-event Cox model using the gap-time approach. However, no existing computer program can implement their method. We follow the suggestion in the technical documentation of the Stata command, stcox, advising to test the assumption for each stratum. We use the function, cox.zph(), in R to conduct the tests.

[8] We test the assumption only for the first five strata because, beyond the fifth stratum, the computer programme returns error messages. To do the test, we need to first estimate the single-spell Cox PH model for each stratum. When estimating for the sixth–eighth strata, the matrix composed of $\mathbf{x}_k$ is singular because some variables have almost uniform values in those strata, resulting in the errors.

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Appendix

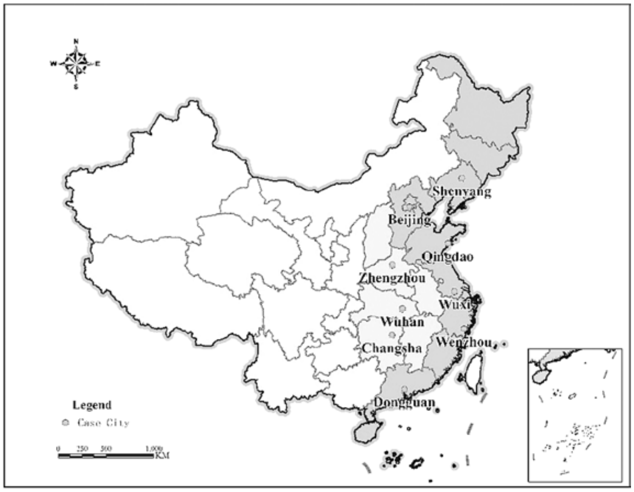

Figure A1. *The locations of the nine Chinese cities in the survey.*
Source: authors' survey.

Table A1. *Tests for the proportional hazard assumption for the baseline specification.*

	The migration times				
	Time = 1	Time = 2	Time = 3	Time = 4	Time = 5
Gender	0.865 (0.352)	0.147 (0.701)	0.071 (0.790)	0.190 (0.663)	1.213 (0.271)
Higher education	3.686 (0.055)*	0.419 (0.517)	1.089 (0.297)	0.664 (0.415)	1.410 (0.235)
Rural *hukou*	0.459 (0.498)	0.282 (0.595)	0.00000 (0.999)	4.520 (0.033)**	2.134 (0.144)
Own farmland	0.001 (0.973)	0.015 (0.902)	4.100 (0.043)**	6.752 (0.009)***	1.032 (0.310)
Age of first migration	2.581 (0.108)	0.003 (0.954)	0.487 (0.485)	1.959 (0.162)	2.746 (0.098)*
Consider social network	0.003 (0.956)	0.309 (0.578)	2.267 (0.132)	0.057 (0.811)	3.795 (0.051)*
Observations	2,163	1,112	487	188	66

Notes: (1) The chi-square statistics for testing the proportional hazard assumption are reported, and the P values are in parentheses. (2) The tests use the scaled Schoenfeld residuals. (3) *$P < 0.1$; **$P < 0.05$; ***$P < 0.01$.
Source: Calculation from authors' survey data.

Table A2. *Tests for the proportional hazard assumption for the alternative specification.*

	The migration times				
	Time = 1	Time = 2	Time = 3	Time = 4	Time = 5
Gender	0.855 (0.355)	0.273 (0.601)	0.460 (0.498)	0.112 (0.738)	1.474 (0.225)
Education: middel school	0.058 (0.810)	1.084 (0.298)	0.003 (0.957)	2.041 (0.153)	0.675 (0.411)
Education: high school	0.213 (0.645)	0.683 (0.408)	2.987 (0.084)*	5.300 (0.021)**	2.459 (0.117)
Education: associate degree	1.854 (0.173)	0.472 (0.492)	3.145 (0.076)*	4.261 (0.039)**	0.187 (0.665)
Education: bachelor and above	1.326 (0.250)	0.004 (0.947)	0.0002 (0.990)	0.0003 (0.987)	0.0000 (1.000)
Rural *hukou*	0.510 (0.475)	0.152 (0.697)	0.015 (0.902)	6.531 (0.011)**	2.397 (0.122)
Own farmland	0.006 (0.939)	0.025 (0.875)	4.858 (0.028)**	6.273 (0.012)**	0.821 (0.365)
Age of first migration	2.273 (0.132)	0.006 (0.938)	0.146 (0.703)	4.211 (0.040)**	3.877 (0.049)**
Consider social network	0.014 (0.906)	0.214 (0.644)	2.563 (0.109)	0.011 (0.918)	3.930 (0.047)**
Observations	2163	1112	487	188	66

Notes: (1) The chi-square statistics for testing the proportional hazard assumption are reported, and the P values are in parentheses. (2) The tests use the scaled Schoenfeld residuals. (3) $*P < 0.1$; $**P < 0.05$; $***P < 0.01$.
Source: Calculation from authors' survey data.