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# The Dynamics of Labour Market Polarization in Chile: An Analysis of the Link Between Technical Change and Informality\*

Isaure Delaporte<sup>†</sup>

Werner Peña<sup>‡</sup>

## Abstract

In spite of the growing literature on polarization, relatively little is known about the individual-level patterns underlying the decline of routine occupations and its link with informal employment in a middle-income country context. To shed light on this, we examine the flows of formal and informal workers into and out of routine and non-routine occupations over the period 1980-2015 in Chile. Using rich longitudinal data from the Social Protection Survey of Chile, we first reconstruct individuals' occupational trajectories by classifying individuals into different states at a monthly frequency. We then use a series of multilevel competing risk event history models and a decomposition flow approach to study the flows underlying the decline of routine occupations over time. Our results suggest a process of displacement and occupational downgrading for routine manual workers: workers in routine manual formal employment become increasingly unemployed or use informality as a buffer against job loss, and workers in routine manual informal employment become unemployed or transit to non-routine manual informal occupations. By contrast, workers in routine cognitive occupations seem to be relatively more protected against job displacement and occupational downgrading. Lastly, we find that the decrease in the share of routine occupations in Chile is mostly due to a decrease in the inflow transition rate from unemployment as well as an increase in the outflow transition rates to unemployment and informality.

**Keywords:** Occupations, Tasks, Routinization, Labour Market Displacement, Unemployment, Informality.

**JEL classification:** E24, E26, J21, J23, J24, O30.

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# 1 Introduction

Over recent decades, labour markets have become increasingly polarized: in many countries, the employment and income shares of routine occupations have declined, while the shares in abstract and manual occupations have increased (Autor, Levy and Murnane 2003; Autor, Katz and Kearney 2006; Autor and Dorn 2009; Acemoglu and Autor 2011; Goos and Manning 2007; Spitz-Oener 2006; Dustmann, Ludsteck and Schonberg 2009; Goos, Manning and Salomons 2009; Goose, Manning and Salomons 2014; Ariza and Raymond Bara 2020; Lewandowski, Park and Schotte 2020; Peña and Siegel 2021). The literature has been attributing this phenomenon to the introduction of new technologies able to perform structured and repetitive tasks (Autor, Levy and Murnane 2003; Acemoglu and Autor 2011). Indeed, routine tasks follow well-defined rules and therefore can become codifiable and performed by a computer or robot. By contrast, manual tasks require basic skills and adaptability to different environments and situations, while abstract tasks entail complex decision-making process, intuition, creativity, and communication ability and can only be performed by workers with high analytical capacity and adaptability.

While this process of technical change and occupational substitution has been well documented in the literature, still little is known about the individual-level patterns underlying the decline of routine employment. Furthermore, this process is likely to disrupt individuals' professional careers, as it pushes some workers to adapt by moving to other types of jobs (Autor 2019). However, a relatively low number of studies have examined the occupational mobility patterns of workers switching in and out of routine jobs (Cortes 2016; Cortes et al. 2017, 2020; Smith 2013; Foote and Ryan 2014). Among these studies, Smith (2013) finds that the decline in the share of workers in middle-skill jobs in the US is due both to a decline in inflows (from non-employment and mostly for younger workers) and to a rise in outflows (to non-employment and to other jobs). Similarly, Cortes et al. (2020) find that the decline in employment in middle-wage routine occupations in the US can be primarily accounted for by changes in transitions rates from non-participation and unemployment to routine employment. Yet, due to data limitations, only a limited number of states were considered, and job-to-job transitions were not investigated.

Furthermore, these studies have focused on high-income countries; thus, less is known about the labour market changes associated with the decline of routine jobs in low- and middle-income countries. Yet, we expect to find additional insights for a number of reasons. First, these countries differ in task endowments (De la Rica et al. 2020; Marcolin et al. 2018; Lewandowski et al. 2019). Jobs in low- and middle-income countries are more routine intensive than in high-income countries (Lo Bello, Sanchez Puerta and Winkler 2019; Peña and Siegel 2021). Besides, there are key differences in terms of whether and how polarization is taking place (Das and Hilgenstock 2018; Maloney and Molina 2016; Messina, Pica and Oviedo 2016; Gasparini et al. 2021). In the last two decades, the shift away from routine work and towards non-routine work in low- and middle-income countries was much slower than in high-income countries (Lewandowski, Park and Schotte 2020; Peña and Siegel 2021). Last but not least, labour markets in low- and middle-income countries

are characterised by a substantial share of the population working in informal employment. Yet, to the best of our knowledge, no studies have examined empirically the link between routine biased technical change and informality.<sup>1</sup> Previous studies have analysed the worker flows between formal employment, informal employment, unemployment, and non-participation (Bosch and Maloney 2008; Albertini et al. 2020). For instance, Bosch and Maloney (2008) show that job separations of informal employment is the most important driver for the unemployment rate dynamic in Brazil and Mexico, while movements in formal employment are largely accounted for by changes in the formal job finding probabilities from all other states. Similarly, Albertini et al. (2020) document that the ins and outs of informal employment are key drivers of labour market fluctuations in Argentina. However, despite documenting important stylized facts on worker flows in Latin America, these studies do not examine the link with technical change.

To fill this gap, this paper investigates the labour market changes in the flows of formal and informal workers into and out of routine and non-routine occupations. We aim to answer two questions: i) what are the main labour market changes that underlie the disappearance of routine jobs in middle-income countries? and ii) what are the links between routine biased technical change and informality? We focus on the case of Chile which has been experiencing a decline in routine employment accompanied by a substantial increase in the adoption of industrial robots over the last decades (Falcone et al. 2022). We use rich longitudinal data from the Social Protection Survey of Chile which contains retrospective biographical information on individuals’ employment history going back to January 1980 until July 2016. This allows us to observe individual-level transitions across labour market states at a monthly frequency. We classify individuals in each month according to their labour market status (employed, unemployed, or out of the labour force), their current occupational group (employed in non-routine cognitive (NRC) occupations, in routine cognitive (RC) occupations, in routine manual (RM) occupations or in non-routine manual (NRM) occupations), and their informality status (formal or informal).

We begin by analysing individuals’ transitions in and out of different occupations over time using a series of multistate competing risks event history models. We compare the relative risks for individuals to move to different states. In this respect, we are especially interested in investigating where do routine formal and informal workers move to given that the risk of being substituted for is supposedly higher for them than for other workers. Nonetheless, we also explore transitions from other occupations as well as from non-employment. Second, we examine how these relative risks of transiting to different states have changed over time since the 1980s, given that the risk of being substituted for is also increasing over time. This allows us to provide a better understanding of the labour market displacement effects of the process of technical change and its links with informal employment. We then investigate to which extent the type of transitions that individuals do vary by sex, age group, and level of education. This allows us first to iden-

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<sup>1</sup>From a theoretical perspective, Gomez (2021) shows that job polarization, driven by routine-biased technological change, increases the size of the informal sector.

tify which demographic groups are the most affected by the process of technical change and second, to ensure that our observed patterns are not due to such differences. We then use a modified version of the flows approach adopted in [Cortes et al. \(2020\)](#) to study the flows underlying the decline of formal and informal routine occupations, and conduct counterfactuals to identify the key changes in transition rates that can account for the decline in routine employment. The counterfactual analysis allows us to disentangle the relative importance of inflows and outflows, but also to quantify the magnitude of their impact in the evolution of the occupational stocks. We also conduct these counterfactual by differentiating by sociodemographic groups. Lastly, since our analysis shows that workers in RM occupations become increasingly unemployed, we conclude our analysis by investigating further where do they transit to after becoming non-employed.

Our results suggest that the decline in the share of routine occupations is mostly due to a decrease in the share of routine manual occupations which is observed both in the formal and informal labour markets. This implies that the process of technical change might not only affect formal workers, but it also has displacement effects among informal workers. Furthermore, our results suggest a process of occupational downgrading for routine manual workers: formal workers employed in routine manual occupations are increasingly more likely to become non-employed or to start to work in the informal sector. This is suggesting that informality is used as a buffer against job loss for individuals working in routine occupations. Workers in routine manual informal employment are more likely to become unemployed or to transit to non-routine manual informal occupations. By contrast, workers in routine cognitive occupations seem to be more protected against job displacement and occupational downgrading.

Furthermore, we find clear differences by sex, age group, and level of education. For instance, regarding workers in RM formal occupations, those who are the most likely to transit to RM informal occupations are low-educated men aged 30 and above. In comparison, women are more likely to become unemployed, irrespective of their age or level of education. Highly educated workers are also more likely to move to non-routine cognitive formal occupations. Among individuals who work in RM informal occupations, women are more likely to become unemployed. By implementing the decomposition flow approach, we find that the decrease in the share of routine occupations in Chile is mostly due to a decrease in the inflow transition rate of routine manual workers from unemployment as well as an increase in the outflow transition rates to unemployment and informality.

Our paper contributes to the literature in the following ways. First, a growing but still relatively low number of studies have examined the occupational mobility patterns of workers switching out of routine jobs ([Cortes 2016](#); [Cortes et al. 2017, 2020](#); [Smith 2013](#); [Foote and Ryan 2014](#); [Schmidpeter and Winter-Ebmer 2021](#)) and all have focused on developed economies. To the best of our knowledge, this is the first study that examines the labour market changes in the flows of workers into and out of routine and non-routine occupations in a middle-income country context. Our rich longitudinal data from Chile enables us to consider many labour market states and to investigate job-to-job transitions.

Our findings suggest that informality is used as a buffer against job loss by RM formal workers. We also document that the displacement effects of automation are not only restricted to formal workers: informal workers also experience displacement effects and occupational downgrading. Furthermore, we document different job reallocation for men and women. These findings highlight the potential role of the process of technical change in creating or exacerbating inequalities between different demographic groups.

Our paper proceeds as follows. In Section 2, we present our data. Section 3 presents a descriptive analysis of the transitions into and out of different occupations in the formal and informal labour markets. In Section 4, we conduct counterfactual exercises to identify the key changes in the transition rates that can account for the decline in routine employment. Lastly, we examine in Section 5 the outcomes of RM workers who have become non-employed before concluding in Section 6.

## 2 Data

We use rich longitudinal data from the Social Protection Survey of Chile. Since 2002, the survey has followed a large sample of individuals to have a representative sample of the Chilean population aged 18 and older. It includes demographic and socioeconomic information at the individual and household levels. More importantly for our purpose, it contains information on individuals' employment histories spanning January 1980 to July 2016. This allows us to observe individual-level transitions across labour market states at a monthly frequency. Furthermore, it allows us to observe changes over a relatively long period (1980-2015) where the process of technical change has been taking place.<sup>2</sup>

Following the recent literature, we consider four broad occupational groups based on the tasks performed on the job: i) non-routine cognitive (NRC) occupations, ii) routine cognitive (RC) occupations, iii) routine manual (RM) occupations, and iv) non-routine manual (NRM) occupations. The distinction between routine and non-routine occupations is based on the definition provided by previous studies (Autor, Levy and Murnane 2003; Autor and Dorn 2013). Specifically, routine occupations are occupations whose tasks involved are a set of specific activities accomplished by following well-defined instructions and procedures. Conversely, an occupation is considered non-routine if the job involves a variety of tasks requiring flexibility, problem-solving, or human interaction skills. Lastly, the distinction between cognitive and manual occupations is based on differences in the extent of mental versus physical activity.

We aggregate detailed occupational codes based on the ISCO-1 digit classification into these four occupational groups. Specifically, *NRC occupations* are Professional, Managerial, Technical and Associate Professional Occupations; *RC occupations* are Clerical Support, Services and Sales Occupations; *RM occupations* are Skilled Agricultural, Forestry and Fishery, Craft and Related Trade, Plant and Machine Operators, and Assemblers Occupations; and *NRM occupations* are Elementary Occupations.<sup>3</sup> Regarding informal-

<sup>2</sup>See Appendix A for a description of the database.

<sup>3</sup>Several approaches have been proposed to measure routinization. One is to create an index of routine

ity, our measure comprises unregistered workers without access to social security benefits, workers with no explicit written contracts, workers in temporary jobs, and low-skilled self-employment, in line with the International Labour Organization’s guidelines on measuring informality (ILO 2013) and following previous studies (Berniell et al. 2021).

Given our occupational categories and also by taking into account the informality status of individuals, we can classify individuals each month into one of the ten following categories: i) employed formally in NRC occupations, ii) employed formally in RC occupations, iii) employed formally in RM occupations, iv) employed formally in NRM occupations, v) employed informally in NRC occupations, vi) employed informally in RC occupations, vii) employed informally in RM occupations, viii) employed informally in NRM occupations, ix) unemployed, or x) inactive. By proceeding this way, we obtain individual-level transitions across labour market states at a monthly frequency. We restrict our sample to individuals aged 15 to 65, observed between January 1980 and December 2015.

Table 1 presents descriptive statistics for the full sample. There is clear heterogeneity across occupations in terms of sex composition: workers in RC occupations are predominantly women (59% compared to 41% of men) whereas RM occupations are predominantly comprised of men (88% compared to only 12% of women). Furthermore, RM and NRM occupations are characterised by a larger proportion of low educated workers compared to NRC occupations (45 and 57% compared to 5% respectively). There is also a larger proportion of formal workers in RC and NRC occupations compared to in RM and NRM occupations (72 and 75% compared to 55 and 48% respectively).

In addition, Figure 1 displays the monthly time series of employment in formality/informality, in routine and non-routine occupations as well as in each occupational group as a share of total employment and separately for formal and informal employment. Figure 1a shows that informal employment represents around 40% of the total employment in Chile. Figure 1b illustrates the decline in routine employment. This decrease starts to take place around the beginning of the 2000s. This is in line with what has been documented in previous studies for Chile (Falcone et al. 2022). Figure 1c shows that the decline in routine occupations is mostly due to a decrease in RM occupations, which started since the beginning of the series.

By contrast, RC occupations have remained more or less stable along the period. This is different from what has been documented in Cortes et al. (2020) for the US, since they have found that the share of RC occupations in total employment has decreased since the

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task content for each occupation based on individual responses related to occupational tasks. The studies that have adopted this approach typically use surveys that provide information on the task content of occupations in the US. However, this information is likely not to be representative of the task content of occupations in middle- and low-income countries. Another survey that previous studies have relied on is the survey from the Programme for the International Assessment of Adult Competencies (PIAAC). It collects information on Chile for the year 2014. However, since we examine a large period (1980-2016), the task content of occupations is likely to have evolved over time and it is therefore debatable whether the resulting measure would be appropriately measuring automation risk over time. Given all these caveats, we give primacy to a relatively more simple but direct interpretation of what routinization means in the context of occupations. Our approach to measure routinization also has some limitations. For instance, we are unable to account for differences in automation risk within occupations. In addition, our measure does not vary over time.



beginning of the 2000s. Lastly, this decrease in RM occupations is due to a decrease in RM formal employment since the beginning of the series (Figure 1d) but also to a decrease in RM informal employment since the beginning of the 2000s (Figure 1e). In the next section, we start to delve deeper into these trends by estimating a series of multilevel competing risk event history models.

Table 1. Descriptive statistics (period 1980-2015)

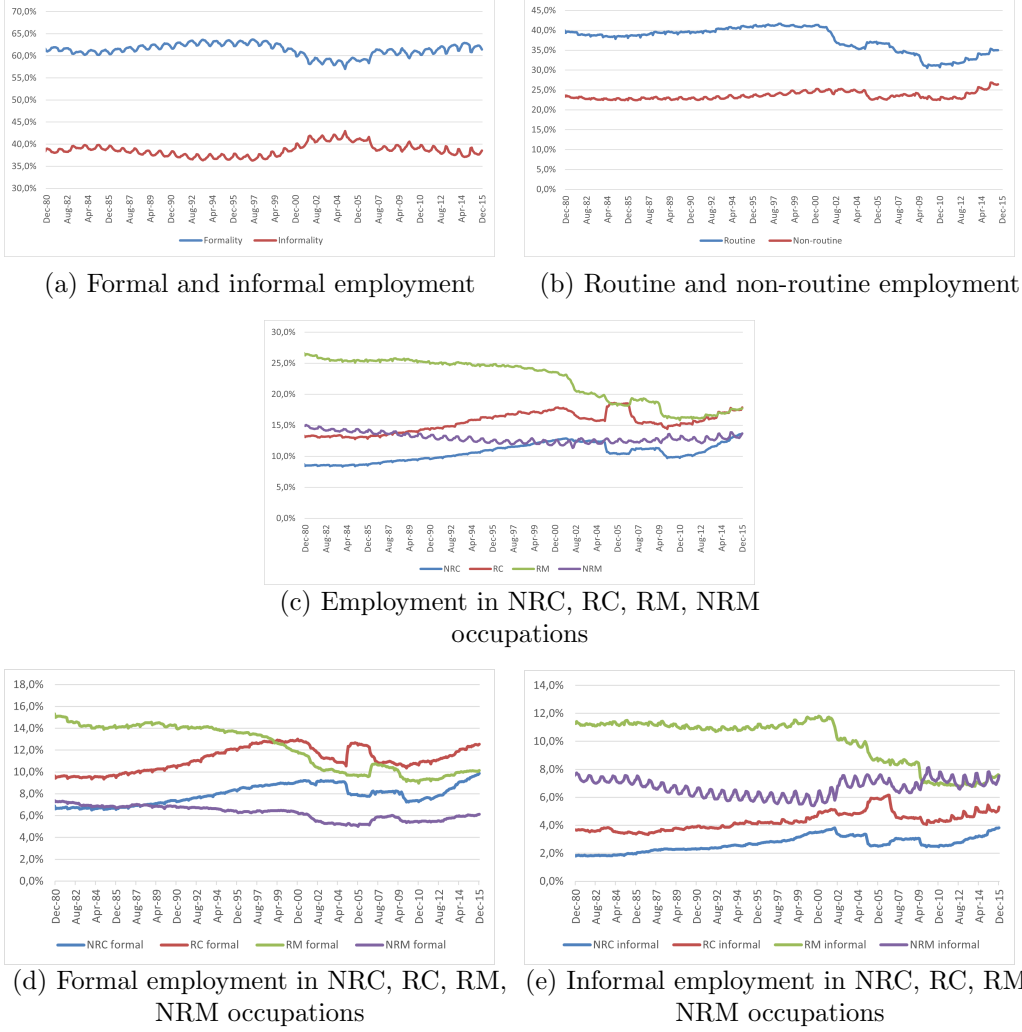
|  | All    | NRC   | RC     | RM     | NRM   | Unemp. | Inactive |
|--|--------|-------|--------|--------|-------|--------|----------|
| <i>Individual characteristics</i>          |        |       |        |        |       |        |          |
| Male (%)                                   | 50     | 54    | 41     | 88     | 54    | 42     | 27       |
| Average age                                | 36     | 38    | 35     | 38     | 38    | 35     | 34       |
| Low education (%)                          | 34     | 5     | 15     | 45     | 57    | 40     | 35       |
| Medium education (%)                       | 54     | 45    | 77     | 53     | 42    | 53     | 52       |
| High education (%)                         | 12     | 50    | 8      | 2      | 1     | 7      | 13       |
| <i>Employment characteristics</i>          |        |       |        |        |       |        |          |
| Self-employee (%)                          | 23     | 26    | 15     | 31     | 15    |        |          |
| Employee (%)                               | 77     | 74    | 85     | 69     | 85    |        |          |
| Formal (%)                                 | 61     | 75    | 72     | 55     | 48    |        |          |
| Permanent job (%)                          | 82     | 92    | 90     | 77     | 72    |        |          |
| Contract signed (%)                        | 84     | 91    | 86     | 85     | 73    |        |          |
| Contributing to social security (%)        | 73     | 81    | 79     | 69     | 68    |        |          |
| Weekly hours worked                        | 47     | 46    | 47     | 49     | 47    |        |          |
| <i>Reason for end of job (%)</i>           |        |       |        |        |       |        |          |
| On mutual agreement                        | 5      | 7     | 5      | 4      | 6     |        |          |
| Resignation                                | 21     | 21    | 29     | 15     | 21    |        |          |
| End of contract                            | 16     | 8     | 8      | 20     | 21    |        |          |
| Dismissal for reasons attributable to self | 2      | 1     | 2      | 2      | 2     |        |          |
| Dismissal due to company needs             | 13     | 12    | 16     | 13     | 11    |        |          |
| Closure of the company                     | 8      | 10    | 8      | 10     | 4     |        |          |
| Found a better job                         | 14     | 15    | 12     | 16     | 13    |        |          |
| Health-related reasons                     | 5      | 2     | 4      | 6      | 6     |        |          |
| Retired                                    | 7      | 11    | 5      | 7      | 6     |        |          |
| Fortuitous event                           | 4      | 4     | 4      | 3      | 5     |        |          |
| Other                                      | 6      | 8     | 7      | 5      | 6     |        |          |
| <i>Reason for inactivity (%)</i>           |        |       |        |        |       |        |          |
| Due to illness or disability               |        |       |        |        |       |        | 9        |
| Childcare                                  |        |       |        |        |       |        | 13       |
| Personal or family responsibilities        |        |       |        |        |       |        | 5        |
| Pregnancy                                  |        |       |        |        |       |        | 1        |
| Studying or training                       |        |       |        |        |       |        | 21       |
| Undertaking internship                     |        |       |        |        |       |        | 0.2      |
| Housework                                  |        |       |        |        |       |        | 34       |
| Retired                                    |        |       |        |        |       |        | 8        |
| Not interested in working                  |        |       |        |        |       |        | 4        |
| Military service                           |        |       |        |        |       |        | 0.7      |
| Other                                      |        |       |        |        |       |        | 3        |
| N  | 27,109 | 6,808 | 11,709 | 10,773 | 9,960 | 11,410 | 20,991   |

*Source:* Social Protection Survey of Chile, authors' own calculations.

Notes: This table presents the descriptive statistics based on the full sample of individuals that have been observed at any time over the period 1980-2015. Since individuals can move to different employment statuses along their lives, one individual can be counted in several of the categories contained in this table. The sample is restricted to individuals aged 15 to 65. The unemployed category comprises individuals in any previous occupational category. The categories for the level of education are constructed based on the highest educational level attained. The reasons for end of job are for individuals that transit from employment to unemployment.



Figure 1. Monthly time series of employment (January 1980 - December 2015)



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: These figures present the monthly time series of employment in formality/informality (Figure 1a), in routine and non-routine occupations (Figure 1b), in each occupational group (Figure 1c) as well as separately for formal (Figure 1d) and informal employment (Figure 1e) as a share of the total employment for the period January 1980 to December 2015.

### 3 Workers' Labour Market Transitions

In this section, our objective is to gain a better understanding of the direction of the flows within employment statuses to have a first approximation of the main labour market changes that underlie the disappearance of middle-wage routine jobs. Therefore, we study individuals' transitions over time by estimating a series of multistate competing risks event history models. We compare the relative risks for individuals to move to different states. We are especially interested in investigating where do routine formal and informal workers move to, since they are the ones that face the highest risk of being substituted for. Nonetheless, we also explore transitions from other occupations as well as from non-employment. We also examine how these relative risks of transiting to different states have changed over time since the 1980s, having in mind that the risk of being substituted

for has increased over time, especially since the beginning of the 2000s. Lastly, we explore to which extent the type of transitions that individuals do vary by sex, age group, and level of education.

### 3.1 Multilevel Multistate Event History Models

To study changes in the employment status of individuals over time, we estimate multilevel multistate event history models. These models are an extension of conventional event history models: rather than analysing a single employment transition, individuals can move to different states. We start by observing all individuals from January 1980. When individuals are in employment, they can either switch between occupations, or go out of employment as unemployed or inactive. Similarly, when individuals are out of employment (as unemployed or inactive), they can either return to employment or become unemployed (if inactive) or inactive (if unemployed).

To understand the link between the decline in routine employment and formal/informal employment, we estimate nine sets of multilevel competing risks event history models for the outcomes of: 1) individuals employed in RM formal occupations, 2) individuals employed in RC formal occupations, 3) individuals employed in NRM formal occupations, 4) individuals employed in NRC formal occupations, 5) individuals employed in RM informal occupations, 6) individuals employed in RC informal occupations, 7) individuals employed in NRM informal occupations, 8) individuals employed in NRC informal occupations, and lastly 9) non-employed individuals (either unemployed or inactive). We focus on these categories to get a sense of which labour market state routine workers have been more likely to transit to over the last 35 years.

We estimate multilevel models because of the fact that each individual can experience several changes in their employment statuses along their careers. Besides, individuals can change their employment status at different points in time. We extend the conventional competing risks model by conducting simultaneous analysis of changing to different employment statuses. The risk of a change in the employment status is thus expressed by:

$$\ln\mu_{im}^k(t) = \ln\mu_0(t) + \sum_j \alpha_j x_{ij} + \sum_l \beta_l w_{il}(t) + \gamma z_i \quad (1)$$

where  $\mu_{im}^k(t)$  denotes the hazard of transiting to the employment status of type  $k$  of order  $m$  (first and subsequent order) for individual  $i$ . For all individuals, this refers to the risk of becoming employed in another occupation or to become non-employed (unemployed or inactive).  $\ln\mu_0(t)$  denotes the baseline log-hazard, which is specified as piecewise constant. The baseline is time (in months) since the first observation. For most individuals, the first observation is in January of the year 1980.

$x_{ij}$  and  $w_{il}$  represent time-constant and time-varying characteristics that influence individuals' propensities to change their employment status. We include sex, age, level of education, and time since the individual started being in the initial state.  $z_i$  denotes an interaction term between the period and the type of employment transition and  $\gamma$  is the

parameter to measure its effect. The model assumes a common baseline for transitions to all employment types and the same effect of covariates, but the employment levels by type of employment statuses can vary by period. These models are fitted using extended data in which each individual has  $k$  records, where  $k$  corresponds to the number of categories in the employment status variable.

### 3.2 Main Results

We summarise our results for the outcomes of individuals employed formally and informally in RM and RC occupations as well as for individuals who are out of employment.<sup>4</sup> Alternatively, the results of the full models are available in Appendix B Tables B.1 to B.9.

We start by examining the outcomes of individuals who are employed in RM formal occupations (Figure 2).<sup>5</sup> These individuals are at risk of transiting to any other occupation as a formal or informal worker or to go out of employment as unemployed or inactive. The reference category is the risk of transiting to inactivity in the 1980s. The results displayed in Figure 2 show that in the 1980s, individuals that were employed in RM formal occupations were more likely to become unemployed or to become employed informally in RM occupations. These relative risks have increased significantly over the years. In the 2010 decade, becoming unemployed or transiting to RM informal occupations remain the most likely outcomes. Having in mind the automation process that the Chilean economy is going through (Falcone et al. 2022), our results suggest that the displacement of routine manual formal workers could cause the enlargement of informal employment.

By contrast, individuals employed in RC formal occupations (Figure 3) were more likely to become inactive or unemployed in the 1980s.<sup>6</sup> This remained the same the following decades. Yet, the relative risks have increased significantly over the years: in the 2010 decade, individuals that were employed in RC occupations are almost three times more likely to move to unemployment or inactivity compared to in the 1980s. If they remain employed, workers in RC formal occupations are more likely to transit to NRC formal and RC informal occupations. Therefore, while workers in RC formal occupations also transit to informality, the cognitive component of this occupation allows them to have a relatively high likelihood of transiting to other occupations within the formal employment market, such as NRC formal occupations.

We now examine the outcomes of informal workers. Individuals who are employed in RM informal occupations (Figure 4) are first more likely to become unemployed in the 1980s. They also are more likely to become inactive or to become employed in RM

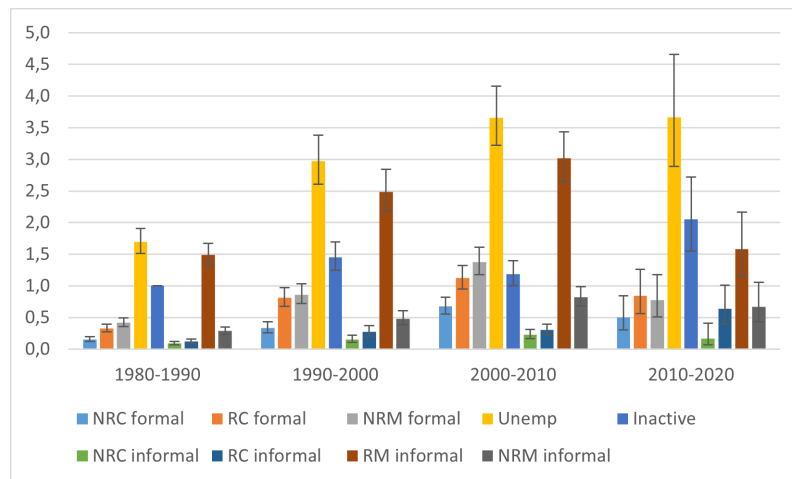
<sup>4</sup>The results for individuals employed formally and informally in NRM and NRC occupations are reported in Appendix B Figures B.1 to B.4.

<sup>5</sup>As a robustness check, we conduct additional analyses where we restrict the sample of individuals who are employed formally in RM occupations to individuals who have lost their job unvoluntarily, e.g. they have either been dismissed due to the company needs or due to the closure of the company. The results reported in Appendix B Figure B.5 remain similar.

<sup>6</sup>As a robustness check, we conduct additional analyses where we restrict the sample of individuals who are employed formally in RC occupations to individuals who have lost their job unvoluntarily, e.g. they have either been dismissed due to the company needs or due to the closure of the company. The results reported in Appendix B Figure B.6 remain similar.

formal occupations in the 1980s. In the 2010 decade, they are much more likely to become unemployed. Along the period, the likelihood of transiting to NRM informal occupations has grown steadily and has slightly surpassed the likelihood of transiting to RM formal occupations in the 2010 decade. As it is shown later, this coincides with the decrease in the stocks of RM informal workers, which started in the 2000s. This finding is also suggesting that automation might be modifying the set of opportunities that RM informal workers have.

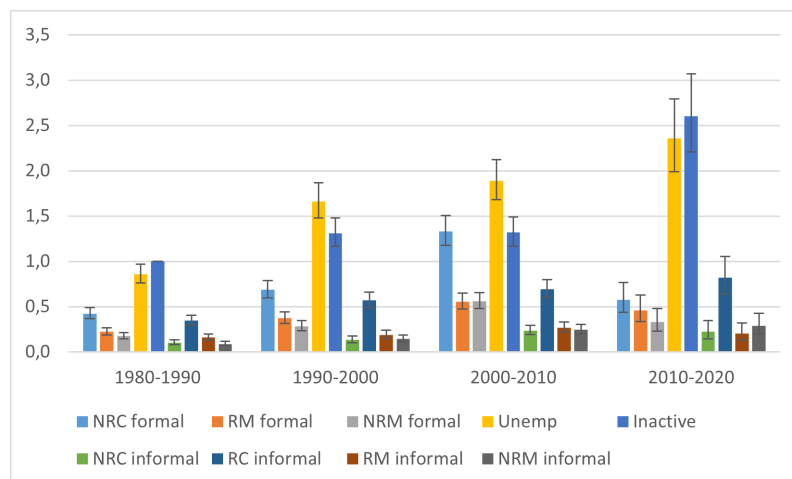
Figure 2. Relative risks of a transition by type of transition over time for RM formal workers



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for RM formal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

Figure 3. Relative risks of a transition by type of transition over time for RC formal workers

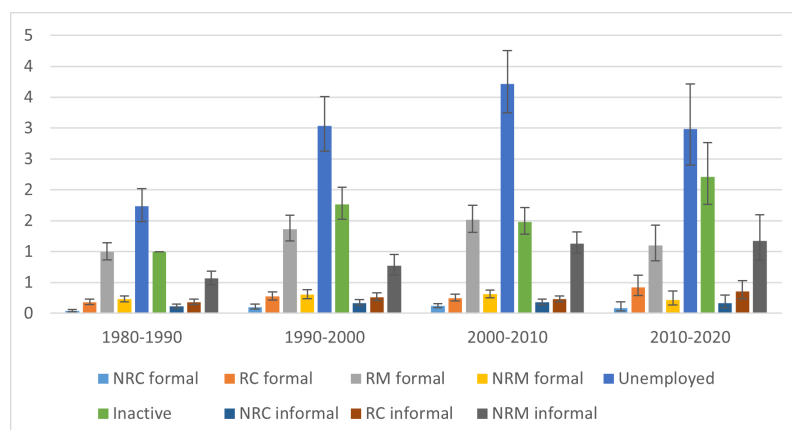


Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for RC formal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

Individuals employed in RC informal occupations (Figure 5) are more likely to become

Figure 4. Relative risks of a transition by type of transition over time for RM informal workers

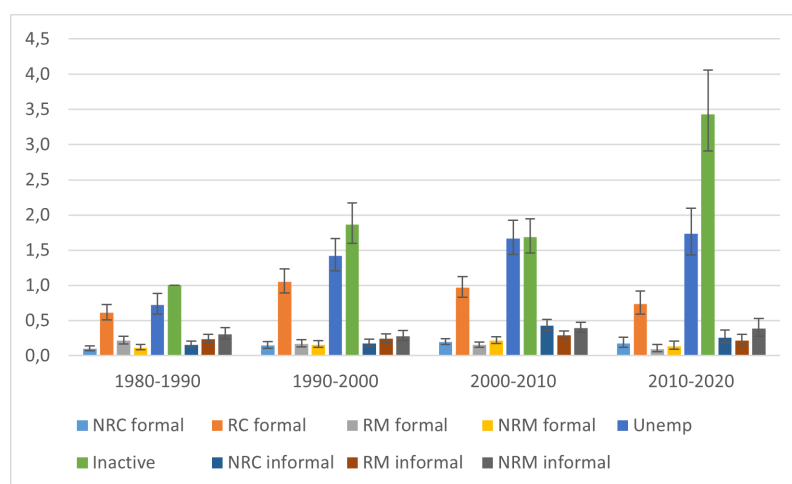


Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for RM informal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

inactive in the 1980s. This remains the case throughout all decades. However, we also show that RC workers in informality might not experience the same impact from automation as RM workers. Indeed, RC informal workers have a higher probability of transiting to the formal labour market (to RC formal occupations) than to remain in informality (to NRM informal occupations). This is consistent with the idea that the cognitive content of tasks is associated with workers being more likely to be in formal employment compared to workers whose jobs involve more predominantly routine manual tasks.

Figure 5. Relative risks of a transition by type of transition over time for RC informal workers



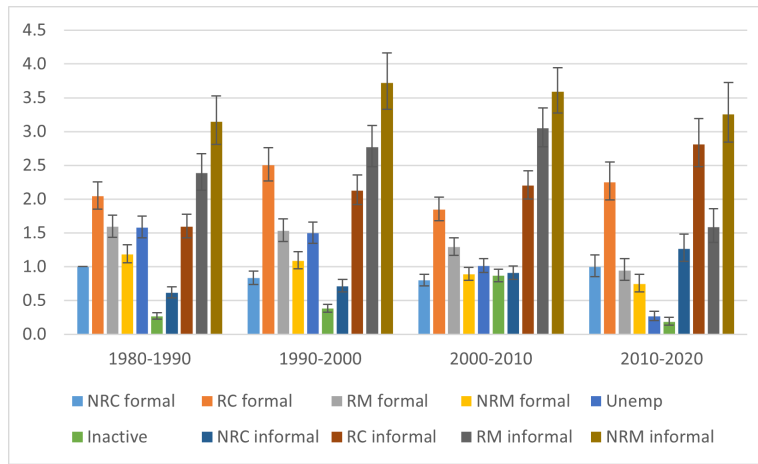
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for RC informal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

We conclude this quick investigation by examining the outcomes of non-employed individuals (either unemployed or inactive). For the moment, we examine all non-employed individuals irrespective of their previous occupational status in employment and study

their relative risks of transiting to other categories. The results are displayed in Figure 6. The reference category is the risk of re-entering the labour market to work in NRC formal occupations in the 1980s. The results show that informality is the most likely outcome for individuals to transit to - more precisely to NRM, RC and RM informal occupations. In the 1980s, individuals who were out of employment were more likely to start to work informally in NRM occupations. This relative risk has increased significantly over the years. The most likely outcome in the formal labour market is to be employed in RC formal occupations. By contrast, the probability of starting to work in RM (both formal and informal) occupations has decreased over the decades.

Figure 6. Relative risks of a transition by type of transition over time for non-employed individuals



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for individuals who are out of employment. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to NRC formal occupations in the 1980s. 95% confidence intervals are also reported.

To summarise, our results highlight three key take away points: i) the work opportunities of routine manual workers, irrespective of whether they are formal or informal workers, have been narrowing over time to occupations in the informal market (RM informal and NRM informal occupations), suggesting a process of occupational downgrading, ii) routine cognitive workers, irrespective of whether they are formal or informal workers, are being relatively less affected by the risk of automation, as their probability to transit into formality is still the highest probability among all the possible transitions into employment, iii) lastly, the probability of going from non-employment to routine manual occupations has decreased over the last two decades. All in all, these identified trends suggest that the displacement of routine manual formal workers might result, all else constant, in an increase in informal employment.

### 3.3 Heterogeneity Across Sociodemographic Groups

So far, we have focused on aggregate transitions rates. Yet, it is well known that labour market transition rates vary significantly across sociodemographic groups. For instance,

young individuals often experience more frequent transitions compared to those who are older. Men and women also often have very distinct labour market trajectories. Thus, we explore to which extent the type of transitions that individuals do vary by sex, age group, and level of education. The results discussed here are reported in Appendix B Figures B.7 to B.15. To ensure a reasonable number of observations, we compare two periods: i) the period between 1980 to 2000, which can be considered as the pre-polarization period and ii) the period between 2000 and 2020, which is the post-polarization period.

Regarding individuals who work in RM formal occupations (Appendix B Figure B.7), men are much more likely to transit to RM informal occupations whereas women are more likely to become unemployed. Highly educated individuals are more likely to move to NRC formal occupations compared to their lower educated counterparts. Among individuals in RC formal occupations (Appendix B Figure B.8), men and women have relatively similar propensities to become unemployed. Yet, the younger individuals are more likely to experience a change in their employment state. Highly educated workers are again more likely to move to NRC formal occupations compared to their lower educated counterparts.<sup>7</sup>

The results among individuals who work in informal occupations are quite stable across occupational groups (Appendix B Figures B.11 to B.14). Overall, women are much more likely to become unemployed or inactive than men. Younger workers are more likely to become unemployed. Lastly, among individuals who are out of employment (Appendix B Figure B.15), men are much more likely to transit to RM informal occupations compared to women. By contrast, women are more likely to transit to RC formal occupations than men, it is the third most likely transition for women. Younger individuals are also more likely to transit to RC formal occupations or to RC informal occupations compared to older individuals.

## 4 Transition Rates and Counterfactual Analysis

In the previous section, we documented that routine manual workers become increasingly unemployed, inactive or use informality as a buffer against job loss. In this section, we aim to gain a deeper understanding of the dynamics behind these trends and the decline of routine occupations. More specifically, we want to understand the role of the transition rates in and out of our ten employment states in explaining these trends. To do so, we use a modified version of the flows approach adopted in [Cortes et al. \(2020\)](#) and conduct counterfactual analyses to unveil the relative importance of inflows and outflows in explaining the trends identified previously. This approach is described in detail in this section.

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<sup>7</sup>The results regarding individuals who work in NRM and NRC formal occupations are available in Appendix B Figures B.9 and B.10.



#### 4.1 Construction of Transition Rates

We start by constructing monthly transition rates across the ten labour market states. The transitions rates from labour market status  $i$  to labour market status  $j$  at date  $t$  ( $\gamma_{ij,t}$ ) are defined as follows:

$$\gamma_{ij,t} = \frac{\sum \tau_{ij,t}}{\sum \tau_{ii,t} - \sum \tau_{il,t} + \sum \tau_{ei,t}} \quad (2)$$

where  $\tau_{ij,t}$  is the transition from status  $i$  at date  $t$  to status  $j$  at date  $t+1$ ,  $\tau_{ii,t}$  is the transition from status  $i$  at date  $t$  to status  $i$  at date  $t+1$  (stayers),  $\tau_{il,t}$  represents workers in status  $i$  at month  $t$  that have left the panel the next month  $t+1$ , and  $\tau_{ei,t}$  represents individuals that have entered the panel and move to status  $i$  at date  $t+1$ .

By using the transition rates, we aim to obtain a mathematical expression that mimics the evolution of the stocks of our employment statuses. To do so, we use the following law of motion to recover the monthly stock evolution of our ten labour market statuses:

$$stocks_{t+1} = inflows_{t+1} - outflows_{t+1} \quad (3)$$

where  $stocks_{t+1}$ ,  $inflows_{t+1}$ ,  $outflows_{t+1}$  are 10x1 matrices. The matrix  $inflows_{t+1}$ <sup>8</sup> is then computed as:

$$inflows_{t+1} = stocks_t * \alpha_t \quad (4)$$

We define  $\alpha_t$  as a 10x10 matrix that is composed of nine sub-matrices as follows:

$$\alpha_t = \begin{bmatrix} \omega_t^{F-F} & \omega_t^{F-N} & \omega_t^{F-I} \\ \omega_t^{N-F} & \omega_t^{N-N} & \omega_t^{N-I} \\ \omega_t^{I-F} & \omega_t^{I-N} & \omega_t^{I-I} \end{bmatrix} \quad (5)$$

where  $\omega_t^{F-F}$  is a 4x4 matrix of transition rates from formality to formality in each of our four occupational groups,  $\omega_t^{F-N}$  is a 4x2 matrix of transitions rates from formality to non-employment (either unemployment or inactivity),  $\omega_t^{F-I}$  is a 4x4 matrix of transitions rates from formality to informality in each occupation,  $\omega_t^{N-F}$  is a 2x4 matrix of transitions rates from non-employment to formality in each occupation,  $\omega_t^{N-N}$  is a 2x2 matrix of transitions rates from non-employment to non-employment,  $\omega_t^{N-I}$  is a 2x4 matrix of transition rates from non-employment to informality,  $\omega_t^{I-F}$  is a 4x4 matrix of transition rates from informality to formality in each occupation,  $\omega_t^{I-N}$  is a 4x2 matrix of transition rates from informality to non-employment,  $\omega_t^{I-I}$  is a 4x4 matrix of transition rates from informality to informality in each occupation. The matrix  $stocks_t$  is then given by:

$$stocks_t = [NRC^F, RC^F, RM^F, NRM^F, U, I, NRC^I, RC^I, RM^I, NRM^I] \quad (6)$$

where the superscript  $F$  stands for formal, the superscript  $I$  stands for informal,  $U$  refers

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<sup>8</sup>Stayers are included in the matrix  $inflows_{t+1}$ .

to unemployment and  $I$  to inactivity. The outflows are given by:

$$outflows_{t+1} = \beta_t * stocks_t^T \quad (7)$$

where matrix  $\beta_t$  is matrix  $\alpha_t$  but with zeros in the main diagonal and  $stocks_t^T$  (the transpose of  $stocks_t$ ) is a column vector (10x1) in which each position has the same order as the row vector  $stocks_t$ . Equipped with our law of motion, the next step is to test its capacity to mimic the monthly evolution of the stocks in each occupation. In this case, by using the transition rates, we should be able to iterate forward in order to reconstruct the observed series of our ten employment statuses.

Figure 7 plots employment in each occupation, unemployment, and inactivity from 1980:1 to 2015:12. The stocks based on the full sample are the blue lines while the estimates based on the law of motion (Equation 3) are the red lines. The figure displays some interesting patterns. While the stocks of NRC occupations (both formal and informal) display ups and downs during the period, there is a positive growth between the end and the beginning of the series (Figures 7a and 7b). The share of NRM occupations has been more or less stable during the period, displaying a slight decrease in the formality share at the end of the series (Figures 7c and 7d).

Figure 7. Labour market stocks from full sample and based on law of motion

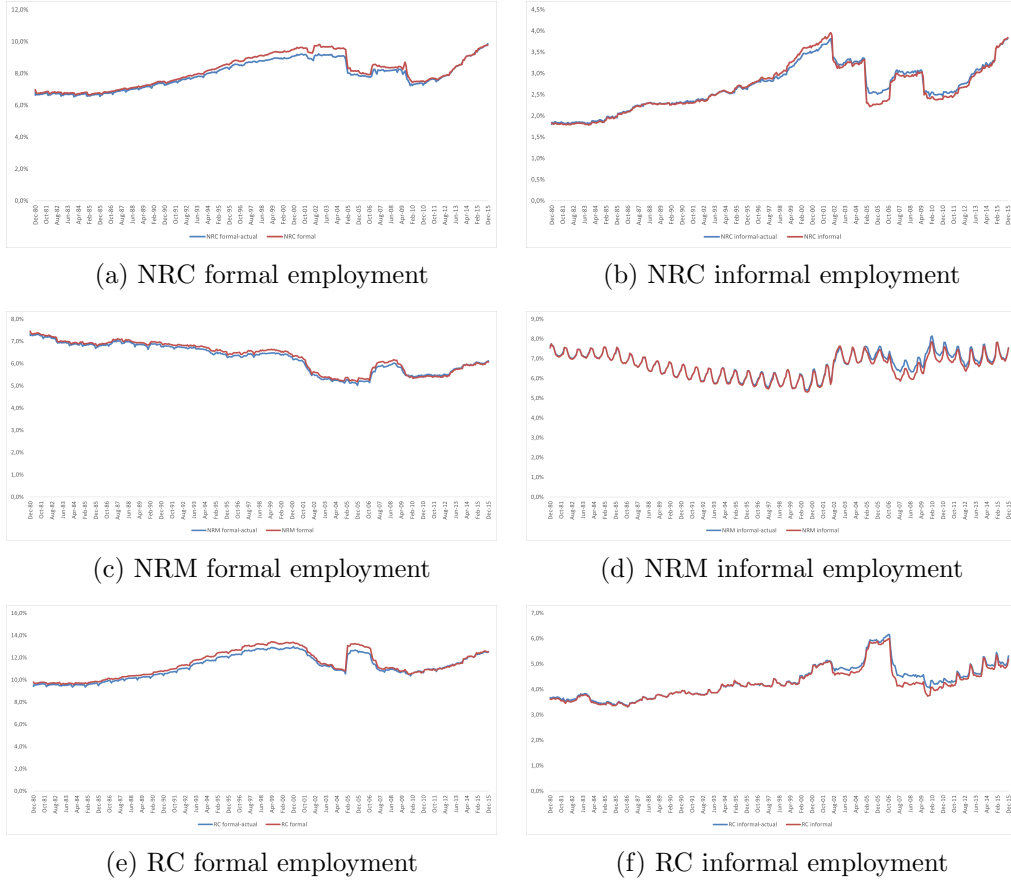
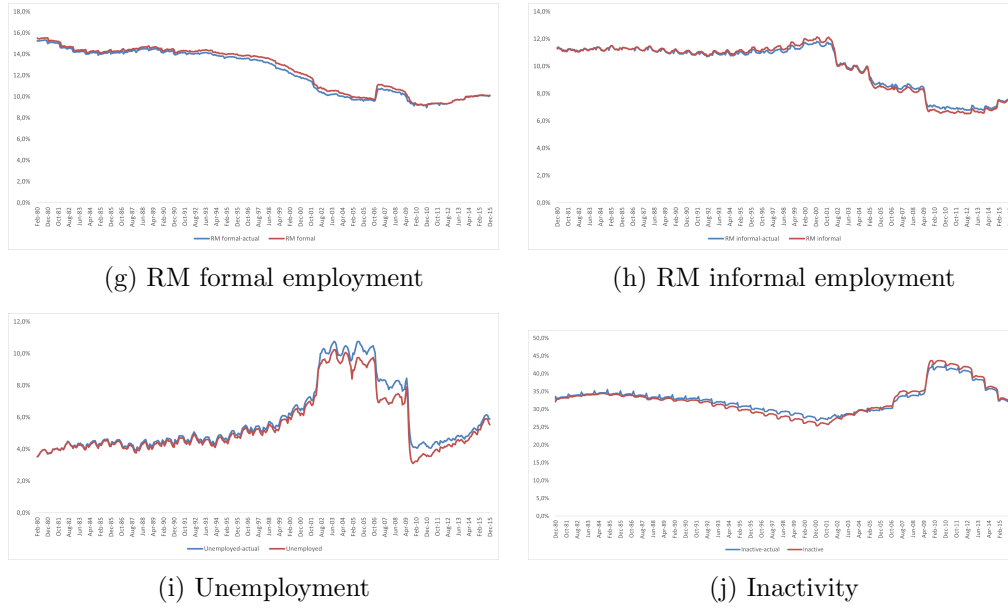


Figure 7. Labour market stocks from full sample and based on law of motion (continued)



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: This figure presents the labour market stocks from the full sample (blue lines) and based on the law of motion (equation 3) (red lines) from January 1980 to December 2015.

Regarding cognitive occupations, they have increased in participation in the total stocks (Figures 7e and 7f) whereas RM occupations display a clear negative trend (Figures 7g and 7h). Furthermore, it is interesting to note that the decline in RM formal stocks starts since the beginning of the series, while the decline in RM informal stocks occurs as recently as the beginning of the 2000s. In other words, the displacement of routine workers due to automation is not a phenomenon that is exclusively happening in formal labour markets since RM informal workers are also affected by this process.

The general patterns observed in each occupation are in line with what has been documented in the literature for middle-income countries (Peña and Siegel 2021). However, by breaking down the occupational statuses by formal/informal employment, we are able to document that the decline in routine occupations in the case of a middle-income country such as Chile is localised in routine manual occupations, and that the process of automation in labour markets has also affected (although with a delay) workers in informality. More specifically, we document increasing probabilities to transit to RM informal occupations (for workers in RM formal occupations) and to NRM informal occupations (for RM informal workers). These patterns, combined with the reduction in the stocks of RM formal and informal employment, suggest that the process of automation is resulting - *ceteris paribus* - in the enlargement of informal employment and occupational downgrading.

Finally, it is important to note that the law-of-motion described by Equation 3 does a good job in replicating the evolution of the observed stocks. This allows us to be confident in implementing the counterfactual analysis presented in the next subsection. Our objective is to disentangle the role of the transition rates (in and out) in explaining the evolution of the ten occupational stocks, with special emphasis on routine occupations

(both formal and informal).

## 4.2 Aggregate Counterfactual

We now study the role of changes in aggregate transition rates into and out of our ten labour market states in accounting for the general patterns showed in the previous section. As Cortes et al. (2020), we would like to smooth the transition rates over the business cycle. Thus, we start by arbitrarily dividing the transition rates into the following phases: 1980-1985, 1986-1990, 1991-1995, 1996-2000, 2001-2005, 2006-2010 and 2011-2015. For each period, we calculate the average transition rates in each of the ten statuses.

Using this information, we construct Table 2 which displays the ratio of the average transition rates between 2011-2015 and 1980-1985. The table shows that job-to-job mobility has increased over the last 35 years for both inflows and outflows. If we consider the outflows (rows in Table 2 - the averages are in the last column), the statuses that, on average, have seen the highest increase in their transition rates compared to in the 1980-1985 period are the NRC formal, RM formal, NRM formal and NRM informal occupations. On the inflows side (columns in Table 2 - the averages are reported in the last row), the statuses that have experienced the largest increase in their inflow transition rates are the NRC formal, RC formal, NRC informal, and RC informal occupations. Importantly, the table also shows that the inflows from unemployment to RM formal and informal occupations are among the few transition rates that have decreased along the period.

Table 2. Ratio of average transition rates between 2011-2015 and 1980-1985

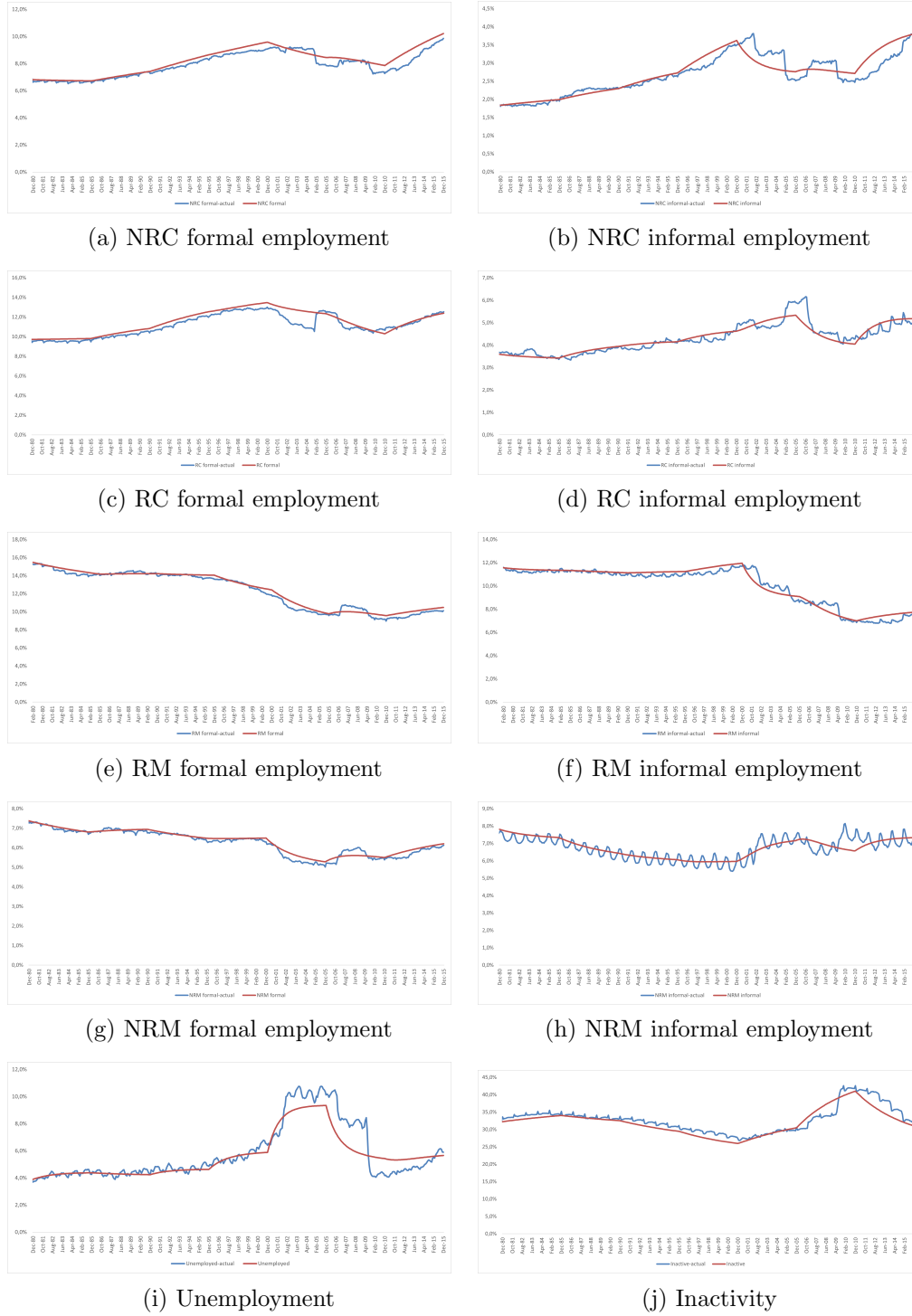
|            |    | $NRC^F$ | $RC^F$ | $RM^F$ | $NRM^F$ | Unemp. | Ina.  | $NRC^I$ | $RC^I$ | $RM^I$ | $NRM^I$ | Averages |
|------------|----|---------|--------|--------|---------|--------|-------|---------|--------|--------|---------|----------|
|            |    | 1       | 2      | 3      | 4       | 5      | 6     | 7       | 8      | 9      | 10      |          |
| $NRC^F$    | 1  | 0.999   | 4.638  | 6.195  | 6.415   | 3.490  | 2.257 | 2.449   | 2.295  | 14.410 | 5.062   | 4.821    |
| $RC^F$     | 2  | 3.682   | 0.999  | 2.033  | 3.388   | 3.520  | 2.843 | 3.130   | 3.933  | 1.455  | 3.079   | 2.806    |
| $RM^F$     | 3  | 6.547   | 3.358  | 0.999  | 2.192   | 2.269  | 1.632 | 2.963   | 6.367  | 2.111  | 2.156   | 3.059    |
| $NRM^F$    | 4  | 9.235   | 4.865  | 1.929  | 0.998   | 1.974  | 1.654 | 2.753   | 4.344  | 1.342  | 2.629   | 3.172    |
| Unemployed | 5  | 2.668   | 2.520  | 0.952  | 1.408   | 0.997  | 1.579 | 6.180   | 2.931  | 0.851  | 1.228   | 2.131    |
| Inactive   | 6  | 2.501   | 2.431  | 1.297  | 1.641   | 0.984  | 0.994 | 3.964   | 4.539  | 1.276  | 2.178   | 2.180    |
| $NRC^I$    | 7  | 2.172   | 3.776  | 2.393  | 5.152   | 3.280  | 3.892 | 0.998   | 3.626  | 1.529  | 2.656   | 2.947    |
| $RC^I$     | 8  | 4.598   | 1.918  | 0.858  | 3.306   | 2.882  | 3.368 | 4.442   | 0.997  | 1.641  | 1.785   | 2.580    |
| $RM^I$     | 9  | 6.223   | 2.938  | 2.063  | 1.630   | 1.598  | 2.100 | 3.370   | 2.960  | 0.997  | 3.157   | 2.704    |
| $NRM^I$    | 10 | 4.558   | 3.997  | 1.755  | 1.908   | 1.553  | 1.758 | 12.205  | 2.895  | 1.453  | 0.995   | 3.308    |
| Averages   |    | 4.318   | 3.144  | 2.047  | 2.804   | 2.255  | 2.208 | 4.245   | 3.489  | 2.706  | 2.493   |          |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: This table presents the ratios between the average transition rates from the period 2011-2015 to the period 1980-1985. The rows represent the outflows of each occupation and the columns represent the inflows.

We proceed by using our average transition rates for the seven periods in our law-of-motion (Equation 3). These “stocks based on average rates” are plotted in Figure 8 alongside the observed monthly stocks. As Cortes et al. (2020), we find that the average period-specific transition rates do a good job in replicating the general patterns observed in the data, in addition to providing smooth series not affected by the Chilean business cycle. Particularly, the stocks based on average transitions also depict the underlying pattern observed in routine manual occupations in the formal and informal labour markets.

Figure 8. Employment stocks based on law of motion using monthly rates and phase averages



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: This figure presents the labour market stocks from the full sample and based on the law of motion (eq. 3) (blue lines) and using the average transition rates per period (red lines), from January 1980 to December 2015.

As our objective lies in understanding the main drivers behind the decline of routine occupations and the links with informal employment, we conduct some counterfactual exercises in which we substitute one by one the period-specific average transition rates by

the average transition rates observed in the pre-polarization period, i.e. 1980-1985. This will allow us to unveil which type of flow (inflow or outflow) is the most important in explaining the patterns observed in the data for each status. To illustrate our exercise, we depart from Equation 3 and modify it as follows:

$$stocks_{t+1}^{cf} = inflows_{t+1}^{cf} - outflows_{t+1}^{cf} \quad (8)$$

In this equation, we observe for the initial period the following:  $stocks_1^{cf} = stocks_1$ ,  $inflows_1^{cf} = inflows_1$  and  $outflows_1^{cf} = outflows_1$ .

Then,

$$inflows_{t+1}^{cf} = stocks_t^{cf} * \alpha_t^{cf} \quad (9)$$

$$outflows_{t+1}^{cf} = \beta_t^{cf} * stocks_t^{T,cf} \quad (10)$$

where  $\alpha_t^{cf}$  and  $\beta_t^{cf}$  are the matrices for the counterfactual transition rates. We construct 100 matrices of counterfactual transition rates where we take one by one each labour market transition and we substitute the period-specific transition rates by the average transition rate of the period 1980-1985 (pre-polarization period).

When conducting this exercise, the total stocks or total number of workers in the counterfactuals will be different to those obtained in the baseline because we modify the transition rates. Therefore, we apply a rule to distribute this difference across the occupations for which the transition rate evolves as in the data. This difference is distributed by using as a weight the participation of the occupation in the total number of workers in those occupations for which the transition rate evolves as in the data in the previous month (see equations 12 and 13).

For example, if we are interested in the counterfactual scenario in which the inflow transition rate from unemployment to NRC formal employment is maintained constant, then the inflows and outflows of the occupations that are not affected by this transition rate are going to be adjusted following these expressions - we take as an example RC formal (where O is any other occupation not involved in this transition):

$$inflows_{t+1,cf,adjusted}^{RCF} = inflows_{t+1,cf}^{RCF} + \frac{inflows_{t,cf}^{RCF}}{\sum inflows_{t,cf}^O} * (inflows_{t+1}^{RCF} - inflows_{t+1,cf,unadjusted}^{RCF}) \quad (11)$$

$$outflows_{t+1,cf,adjusted}^{RCF} = outflows_{t+1,cf}^{RCF} + \frac{outflows_{t,cf}^{RCF}}{\sum outflows_{t,cf}^O} * (outflows_{t+1}^{RCF} - outflows_{t+1,cf,unadjusted}^{RCF}) \quad (12)$$

Using the expressions above, we adjust the inflows and outflows to match the total number of workers in the counterfactual scenario with the baseline scenario. We repeat

this process 100 times, as we have 100 transition matrices.

Among the 10 statuses, we distinguish between those that exhibit a negative trend from those that exhibit a positive trend over the period from 1980 to 2015. The statuses that have experienced a positive trend are NRC formal, RC formal, unemployment, inactivity, NRC informal, and RC informal. Those displaying a negative trend are RM formal, NRM formal, RM informal, and NRM informal. For the series with a positive trend, we then subtract from the smallest point the last point of the series (December 2015) while for the series with a negative trend we subtract from the last point of the series (December 2015) the highest point. Mathematically, for the series going upwards, we have:

$$\Delta stock^O = stock_{smallest}^O - stock_T^O \quad (13)$$

$$\Delta stock_{cf}^O = stock_{cf,smallest}^O - stock_{cf,T}^O \quad (14)$$

and for the series going downwards, we have:

$$\Delta stock^O = stock_T^O - stock_{highest}^O \quad (15)$$

$$\Delta stock_{cf}^O = stock_{cf,T}^O - stock_{cf,highest}^O \quad (16)$$

where  $O$  represents our ten employment statuses. Finally, we compute the following expression:

$$1 - \frac{\Delta stock_{cf}^O}{\Delta stock^O} \quad (17)$$

The rationale of equation 17 is that, for the series going upwards, the counterfactual will tell us how much of this increase would have been lost (if the value is positive) or gained (if the value is negative) if the transition rate had been the same as during the 1980-1985 period. Conversely, for the series going downwards, the counterfactual will tell us how much of this decrease would have been avoided (if the value is positive) or magnified (if the value is negative) if the transition rate had been the same as during the 1980-1985 period. This exercise will allow us to identify which inflows and outflows are the most important to explain the decrease in routine occupations and its relationship with informality.

### 4.3 Results of Aggregate Counterfactual

We first present in Table 3 the percentage point difference between the smallest point and the last observation of the series for those stocks with upward trend, and the difference between the last point and the highest point of the series for the stocks with downward trend. In addition, Table 4 depicts the counterfactual scenarios computed using equations 8 to 17 for our categories. Each of the employment statuses in the first rows of Table 4 has



its inflow and outflow rates resulting from the counterfactual exercises in the corresponding columns. Each position represents the counterfactual value resulting from leaving the corresponding transition rate at the 1980-1985 value.

Table 3. Percentage point variation of employment stocks

| Status       | Value | Upward/downward |
|--------------|-------|-----------------|
| NRC formal   | 3.5%  | Upward          |
| RC formal    | 2.7%  | Upward          |
| RM formal    | -5.0% | Downward        |
| NRM formal   | -1.3% | Downward        |
| Unemployed   | 2.1%  | Upward          |
| Inactive     | 5.0%  | Upward          |
| NRC informal | 2.0%  | Upward          |
| RC informal  | 1.8%  | Upward          |
| RM informal  | -4.2% | Downward        |
| NRM informal | -0.7% | Downward        |

*Source:* Social Protection Survey of Chile, authors' own calculations.

When the information contained in Table 3 is combined with Table 4, we gain several important insights. We focus our attention on RM and RC occupations as well as non-employment. First, regarding RM formal employment, the inflows column tells us that if the rates had been the same as in the 1980-1985 period (smaller inflow rates), the decrease in RM formal employment would have been greater. Interestingly, the inflows from RM informal employment have prevented a larger decrease in RM formal occupations.

An important point to notice is also that the counterfactual exercise of leaving constant the inflows from unemployment to RM formal employment increases the stocks of RM formal occupations. This is due to the fact that the inflows from unemployment to RM formal employment were higher in the 1980-1985 period than in later decades.

When analysing in more detail the role of the outflows, we find that outflows to unemployment and RM informal occupations are the ones with the highest explanatory power for the decrease in RM formal employment. When we consider the net flows to explain the decrease in RM formal employment, the participation of RM informal employment becomes almost null and the participation of RC informal employment becomes positive. However, unemployment remains with a high explanatory power, explaining 34% of the decrease in RM formal occupations. This means that, in the short run, those that have lost their job due to automation in RM formal employment likely became unemployed or, to a lesser extent, transited to informality. Overall, these results point out that the most important driver in the decrease of RM formal occupations are the increase in the outflow transition rates and the decrease in the inflow transition rate from unemployment.

Regarding RC formal employment, we observe that the inflows from unemployment and inactivity play an important role in explaining its increase over the period. Indeed, the ratio of the average transition rates calculated in Table 2 shows a considerable increase of the inflows from the non-employment categories to RC formal occupations. Regarding the outflows, we document that if the rates had remained the same as in 1980-1985, then the increase in RC formal employment would have been higher, the most important statuses being unemployment, and inactivity.

Table 4. Results from aggregate counterfactual exercises

|         | $NRC^F$    |          |           | $RC^F$  |          |           | $RM^F$  |          |           | $NRM^F$ |          |           | Unemployment |          |           |
|---------|------------|----------|-----------|---------|----------|-----------|---------|----------|-----------|---------|----------|-----------|--------------|----------|-----------|
|         | Inflows    | Outflows | Net Flows | Inflows | Outflows | Net Flows | Inflows | Outflows | Net Flows | Inflows | Outflows | Net Flows | Inflows      | Outflows | Net Flows |
| $NRC_F$ |            |          |           | 0.05    | -0.46    | -0.41     | -0.07   | 0.08     | 0.01      | -0.06   | 0.05     | -0.01     | 0.15         | -0.13    | 0.02      |
| $RC_F$  | 0.18       | -0.37    | -0.19     |         |          |           | -0.11   | 0.12     | 0.01      | -0.40   | 0.45     | 0.05      | 0.36         | -0.27    | 0.08      |
| $RM_F$  | 0.14       | -0.12    | 0.01      | 0.16    | -0.16    | -0.01     |         |          |           | -0.34   | 0.37     | 0.03      | 0.18         | 0.01     | 0.19      |
| $NRM_F$ | 0.05       | -0.04    | 0.02      | 0.16    | -0.18    | -0.02     | -0.12   | 0.11     | -0.01     |         |          |           | 0.10         | -0.05    | 0.05      |
| Unemp.  | 0.27       | -0.31    | -0.04     | 0.50    | -0.79    | -0.29     | 0.001   | 0.34     | 0.34      | -0.30   | 0.59     | 0.28      |              |          |           |
| Ina.    | 0.39       | -0.25    | 0.14      | 0.55    | -0.76    | -0.21     | -0.08   | 0.13     | 0.04      | -0.44   | 0.40     | -0.03     | -0.08        | -0.15    | -0.23     |
| $NRC_I$ | 0.22       | -0.14    | 0.08      | 0.09    | -0.08    | 0.02      | -0.02   | 0.02     | 0.00      | -0.04   | 0.02     | -0.01     | 0.14         | -0.14    | 0.00      |
| $RC_I$  | 0.10       | -0.04    | 0.06      | 0.14    | -0.25    | -0.11     | -0.002  | 0.05     | 0.05      | -0.17   | 0.12     | -0.05     | 0.25         | -0.21    | 0.04      |
| $RM_I$  | 0.05       | -0.06    | -0.01     | 0.09    | -0.05    | 0.04      | -0.27   | 0.26     | -0.01     | -0.14   | 0.13     | -0.01     | 0.15         | 0.06     | 0.21      |
| $NRM_I$ | 0.04       | -0.03    | 0.01      | 0.15    | -0.10    | 0.05      | -0.08   | 0.06     | -0.02     | -0.48   | 0.37     | -0.11     | 0.15         | -0.09    | 0.06      |
|         | Inactivity |          |           | $NRC^I$ |          |           | $RC^I$  |          |           | $RM^I$  |          |           | $NRM^I$      |          |           |
|         | Inflows    | Outflows | Net Flows | Inflows | Outflows | Net Flows | Inflows | Outflows | Net Flows | Inflows | Outflows | Net Flows | Inflows      | Outflows | Net Flows |
| $NRC_F$ | 0.13       | -0.07    | 0.06      | 0.11    | -0.18    | -0.07     | 0.02    | -0.07    | -0.04     | 0.00    | 0.00     | -0.01     | -0.07        | 0.10     | 0.02      |
| $RC_F$  | 0.25       | -0.11    | 0.14      | 0.07    | -0.09    | -0.02     | 0.21    | -0.18    | 0.02      | 0.00    | 0.01     | 0.01      | -0.25        | 0.39     | 0.14      |
| $RM_F$  | 0.01       | 0.01     | 0.02      | 0.03    | -0.03    | 0.00      | 0.07    | 0.00     | 0.07      | -0.08   | 0.08     | 0.01      | -0.21        | 0.24     | 0.03      |
| $NRM_F$ | 0.04       | -0.02    | 0.02      | 0.01    | -0.02    | -0.01     | 0.05    | -0.06    | -0.01     | 0.00    | 0.00     | 0.01      | -0.35        | 0.41     | 0.06      |
| Unemp.  | 0.53       | -0.09    | 0.44      | 0.36    | -0.33    | 0.03      | 0.42    | -0.49    | -0.07     | 0.00    | 0.13     | 0.13      | -0.70        | -0.97    | -1.67     |
| Ina.    |            |          |           | 0.61    | -0.40    | 0.22      | 0.77    | -1.01    | -0.24     | -0.01   | 0.03     | 0.02      | -2.25        | 1.00     | -1.24     |
| $NRC_I$ | 0.22       | -0.22    | 0.00      |         |          |           | 0.06    | -0.10    | -0.04     | -0.02   | 0.00     | -0.02     | -0.07        | 0.14     | 0.07      |
| $RC_I$  | 0.51       | -0.40    | 0.11      | 0.14    | -0.07    | 0.06      |         |          |           | -0.02   | 0.04     | 0.02      | -0.27        | 0.38     | 0.11      |
| $RM_I$  | 0.24       | 0.04     | 0.28      | 0.04    | -0.03    | 0.01      | 0.07    | -0.05    | 0.03      |         |          |           | -0.71        | 0.31     | -0.40     |
| $NRM_I$ | 0.27       | -0.27    | 0.00      | 0.06    | -0.03    | 0.03      | 0.12    | -0.08    | 0.04      | 0.00    | 0.10     | 0.10      |              |          |           |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: In this table, each occupation in the first row has its own counterfactual scenarios (inflows and outflows) in the second row. For example, if we take  $NRC^F$  in the first row and we focus on the inflows coming from  $RC^F$  (value of 0.18), then the counterfactual exercise is performed by holding the inflow transition rate from  $RC^F$  to  $NRC^F$  at its 1980-1985 value, and the result of this exercise is that the stocks of  $NRC^F$  would be 18% smaller at the end of the series in this counterfactual, which alternatively means that the inflows from  $RC^F$  to  $NRC^F$  explain approximately 18% of the increase in  $NRC^F$  stocks, holding everything else constant. To interpret this table, it is important to know whether the series' stock is going upward or downward along the period (See Table 3). When the series is going upward, the inflows column (with a positive value) indicates by how much the increase would have been mitigated if the corresponding inflow rate would have remained at its 1980-1985 value. In the case of the outflows (with a negative value), it indicates how much bigger would have been the growth in the stocks if the outflows transition rate had remained at its pre-polarization value. When the series' stock is going downward, then the inflows column (with a negative value) tells us by how much the decrease would have been greater if the corresponding inflow rate had remained at its 1980-1985 value. The outflows (with a positive value) give an indication of how smaller would have been the decrease in the corresponding status if the transition rate had been equal to its value at the pre-polarization period.

Our findings related to informality depict similar trends to what has been reported for our occupational categories in the formal labour markets. RM informal employment decreases along the period, and we document that the decrease in this employment status would have been 8% higher had the inflows from RM formal employment remained at their pre-polarization values. Therefore, the increase in the inflows over the decades has prevented a greater decrease in the participation of RM informal occupations.

There are also net flows going to unemployment and NRM informal employment. This suggests that the automation process in the informal labour market has displaced workers: they have become either unemployed or employed in NRM informal occupations. Regarding RC informal employment, while there are quantitative differences, we observe qualitatively the same results as for RC formal employment. Non-employment constitutes an important share of the inflows and outflows for this occupation. Nonetheless, when considering the net terms, flows from RM formal occupations have a positive impact in explaining the growth in RC informal employment.

Finally, regarding the unemployment category, we find that RM formal and RM informal employment are the biggest net contributors to unemployment. In fact, the outflows column demonstrates that the growth in unemployment would have been smaller if the outflows transition rate to RM occupations had stayed at its 1980-1985 value. This is due to the fact that the transition rates have decreased over time (as shown in Table 2). In other words, less workers are making the transition from unemployment to RM occupations as the automation process takes place. Overall, inactivity shows similar patterns as for unemployment.

To summarise, our results indicate that the increase in the outflows transition rates and the decrease in the inflow rate from unemployment are the most important drivers of the decrease in routine employment. For RM formal employment, the outflows towards unemployment have the highest explanatory power, while the outflows to RM informal employment are second. For RM informal employment, we find that the outflows to unemployment and to NRM informal occupations are the most important ones.

#### 4.4 Counterfactuals by Demographic Groups

In our previous exercises, we held the aggregate transition rates constant at their pre-polarization values to evaluate their role in accounting for the general patterns shown for our ten employment statuses. In doing so, we are effectively assuming that both the demographic composition and the transition propensities amongst demographic groups are constant (Cortes et al. 2020). However, the demographic changes (in terms of age and educational attainment) experienced by the Chilean workers as well as the transition rates differ over time and across groups. Both these channels might have implications for our results in terms of job displacement due to automation and its links with informality.

Indeed, if we were to find that the demographic composition is the main reason of the evolution in our occupational stocks, then the displacement of RM workers would be the result of the demographic transition. On the other hand, if the transition rates

were to be the most important, then automation would likely be behind our documented patterns. Thus, in this subsection, we conduct counterfactuals to estimate: i) the share of the evolution in occupational stocks that is due to the demographic composition and ii) the share that is due to the different propensities across demographic groups to make certain types of transitions. Following (Cortes et al. 2020), when we consider demographic groups, occupational stocks can be described by the following equation:

$$stocks_t = \sum_{j=1}^J \mu_{j,t} stocks_{j,t} \quad (18)$$

where  $\mu_{j,t}$  represents the share of each demographic group  $j$  in the working-age population at month  $t$ .  $stocks_{j,t}$  is a 10x1 matrix that contains the occupational stocks for a demographic group  $j$ . It is then possible to modify our law of motion to estimate the stock evolution of our ten occupational statuses by using the following expression:

$$stocks_{j,t+1} = inflows_{j,t+1} - outflows_{j,t+1} \quad (19)$$

where  $stocks_{j,t+1}$ ,  $inflows_{j,t+1}$ ,  $outflows_{j,t+1}$  are 10x1 matrices for a demographic group  $j$ . Then,  $inflows_{j,t+1}$  is computed as:

$$inflows_{j,t+1} = stocks_{j,t} * \alpha_{j,t} \quad (20)$$

$$stocks_{j,t} = [NRC^F, RC^F, RM^F, NRM^F, U, I, NRC^I, RC^I, RM^I, NRM^I] \quad (21)$$

and outflows:

$$outflows_{j,t+1} = \beta_{j,t} * stocks_{j,t}^T \quad (22)$$

where  $\alpha_{j,t}$  and  $\beta_{j,t}$  are transition matrices for the demographic group  $j$  (analogous to the ones computed in previous sections). We can then notice that the evolution of the aggregate occupational stocks is equal to:

$$stocks_{j,t+1} = \sum_{j=1}^J \mu_{j,t} * stocks_{j,t} * \alpha_{j,t} - \sum_{j=1}^J \mu_{j,t} * \beta_{j,t} * stocks_{j,t}^T \quad (23)$$

Next, equipped with these equations, we can conduct counterfactuals to separate the effect due to changes in the population composition from the effect due to changes in the propensities of transiting to different occupational statuses. To do so, we consider 12 demographic groups resulting from combining the following characteristics: sex (men and women), schooling (low, medium, and high) and age groups (15-29 and 30+). Then, by estimating the previous equations, we can recover the stocks' evolution for each of these occupational stocks.

As Cortes et al. (2020), we run two types of counterfactuals. In the first type of coun-

terfactuals, we keep constant the demographic composition ( $\mu_{j,t}$ ) at their pre-polarization values and let the transition rates for each demographic group evolve over time as in the data. This set of counterfactuals will inform us about the role of changes in the demographic composition in the evolution of the occupational stocks over time. Basically, this implies the following:

$$stocks_{j,t+1}^{cf} = \sum_{j=1}^J \mu_{j,t}^{cf} * stocks_{j,t} * \alpha_{j,t} - \sum_{j=1}^J \mu_{j,t}^{cf} * \beta_{j,t} * stocks_{j,t}^T \quad (24)$$

In the second set of counterfactuals, we keep the transition rates constant at their pre-polarization values and let the other transition rates and demographic groups' shares evolve over time as in the data. This set of counterfactuals will inform us about the role of changes in the transition propensities in explaining the evolution of the occupational stocks. In algebraic terms, this counterfactual exercise is summarised by the following expression:

$$stocks_{j,t+1}^{cf} = \sum_{j=1}^J \mu_{j,t} * stocks_{j,t}^{cf} * \alpha_{j,t}^{cf} - \sum_{j=1}^J \mu_{j,t} * \beta_{j,t}^{cf} * stocks_{j,t}^{T,cf} \quad (25)$$

In both sets of counterfactuals, we are keeping constant either the demographic group's shares or the group's specific transition rates. Doing this leads to the fact that the total stocks do not add up to their aggregate values (just as in section 4.2). The next step is then to redistribute the difference: in the first counterfactuals, we distribute the difference using as weights the occupational stocks of the previous month while in the second counterfactuals, we apply the same strategy as in section 4.2. Finally, we compute the following equation for the two types of counterfactuals using the same rationale as in section 4.2:

$$1 - \frac{\Delta stock_{cf}^O}{\Delta stock^O} \quad (26)$$

#### 4.5 Results of Counterfactuals by Demographic Groups

We present the results for the two sets of aggregate counterfactuals in Tables 5 and 6. Table 5 presents the results for the first set of aggregate counterfactuals (using the net flows) when the demographic changes are held constant at their pre-polarization values and when the transition rates for each demographic group evolve over time as in the data (equation 24). Table 6 shows the results for the second set of aggregate counterfactuals (using the net flows) when keeping the corresponding transition rates constant at their pre-polarization values, and the other transition rates and demographic groups' shares evolve as in the data (equation 25).

The results of Table 5 show that the demographic change plays an important role in shaping the evolution of NRC formal and NRM formal employment. While for NRC formal and informal, the demographic change explains between 58% and 72% of the increase in the corresponding stocks, for NRM formal and informal employment, almost 100% of the

decrease in both stocks would have been avoided if the demographic shares had not changed over the period. Both results are in line with the increase in educational attainment and the ageing population that Chile is experiencing.

On the other hand, for routine occupations, the demographic change seems to play a smaller role. Indeed, for RC formal employment, it explains 39% of its increase over the period (likely influenced by the increase in educational attainment) whereas for RM formal workers, it only explains 3% of its decrease. Similar results are observed for informality, yet for RC workers if the demographic groups' occupational shares had remained at their pre-polarization values, the increase in the stock would have been 3% higher.

Table 5. Results from aggregate counterfactuals (net flows) - demographic group's shares held constant at their January 1980 value

| Status                  | Net effect |
|-------------------------|------------|
| NRC formal (Upward)     | 0.58       |
| RC formal (Upward)      | 0.39       |
| RM formal (Downward)    | 0.03       |
| NRM formal (Downward)   | 1.00       |
| Unemployed (Upward)     | -0.09      |
| Inactive (Upward)       | 0.31       |
| NRC informal (Upward)   | 0.72       |
| RC informal (Upward)    | -0.03      |
| RM informal (Downward)  | 0.36       |
| NRM informal (Downward) | 1.00       |

*Source:* Social Protection Survey of Chile, authors' own calculations.

Notes: This table presents the net results (inflows and outflows) for the aggregate counterfactual maintaining demographic group's shares constant at their January 1980 value. When the series is going upward, a positive value indicates by how much the increase would have been mitigated if the demographic group's shares would have remained constant at their pre-polarization value; whereas a negative value indicates how much bigger would have been the growth in the stocks if the demographic group's shares had remained at their pre-polarization value. When the series' stock is going downward, a positive value indicates how smaller would have been the decrease in the corresponding stock if the demographic group's shares had remained at their pre-polarization value; while a negative value tells us by how much the decrease would have been greater if the demographic group's shares had been equal to their value at the pre-polarization period.

The analysis is complemented by the net flows presented in Table 6 in which we keep the group-specific transition rates constant and the demographic groups' shares evolve as in the data. For NRC and NRM formal and informal, we find that outflows take a more preponderant role in comparison to in Table 4 (there are more negative values), whereas for routine occupations the results are very similar to those found in Table 4. By comparing Tables 5 and 6, we can identify a pattern: for routine occupations, the group-specific transition rates tend to play a more important role in explaining the evolution of the stock than demographic change. More specifically, for RM formal workers, the bulk of the decrease in their stock between 1980-2015 is attributable to endogenous transitions and it is not driven by changes in the demographic composition (rise in educational attainment and population ageing). Thus, for RM formal workers, automation is likely to be behind the decrease in its stocks along the period.

Table 6. Results from aggregate counterfactual (net flows) - demographic group's transition rate constant at their 1980-1985 value

|              | $NRC^F$ | $RC^F$ | $RM^F$ | $NRM^F$ | Unemp. | Ina. | $NRC^I$ | $RC^I$ | $RM^I$ | $NRM^I$ |
|--------------|---------|--------|--------|---------|--------|------|---------|--------|--------|---------|
| $NRC_F$      |         | -0.25  | 0.00   | -0.01   | 0.15   | 0.22 | -0.04   | -0.02  | -0.01  | -0.02   |
| $RC_F$       | -0.03   |        | -0.02  | 0.01    | 0.18   | 0.38 | -0.01   | 0.00   | 0.01   | -0.04   |
| $RM_F$       | 0.00    | -0.03  |        | 0.11    | 0.16   | 0.09 | 0.00    | 0.06   | 0.02   | -0.04   |
| $NRM_F$      | 0.01    | 0.01   | -0.03  |         | 0.02   | 0.05 | -0.02   | -0.04  | -0.01  | 0.01    |
| Unemployment | -0.19   | -0.38  | 0.30   | 0.15    |        | 0.34 | -0.07   | -0.02  | -0.01  | -2.61   |
| Inactivity   | -0.23   | -0.40  | 0.22   | 0.05    | -0.25  |      | -0.34   | -0.27  | 0.11   | -1.07   |
| $NRC_I$      | 0.04    | 0.01   | -0.01  | -0.03   | 0.04   | 0.27 |         | -0.05  | -0.03  | 0.05    |
| $RC_I$       | 0.02    | 0.00   | 0.03   | -0.07   | 0.00   | 0.30 | 0.06    |        | 0.01   | 0.04    |
| $RM_I$       | -0.02   | 0.02   | -0.01  | -0.05   | 0.16   | 0.26 | 0.02    | -0.02  |        | -0.67   |
| $NRM_I$      | -0.01   | -0.03  | 0.01   | -0.15   | -0.08  | 0.10 | 0.03    | 0.02   | 0.09   |         |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The interpretation of this table is the same as the one applied to the net flows in Table 4.

We conclude our study by investigating in the last section the outcomes of non-employed individuals who were previously employed in RM occupations. Indeed, given that one of our main findings is that outflows to unemployment and informality and inflows from unemployment are important contributors to the decrease in RM occupations, we would like to understand further how these states interact with each other. Therefore, we focus our attention on non-employed individuals who were previously employed in RM occupations to see which labour market transitions they are the most likely to undertake upon re-entry in the labour market.

## 5 Outcomes of Non-employed Individuals Previously in RM Occupations

In the previous sections, we have shown that workers in RM occupations are increasingly becoming unemployed over time and at the same time, less unemployed individuals go back to the labour market to be employed in RM occupations. This partly leads to the decrease of RM occupations. In addition, we have identified that workers in RM occupations are increasingly transiting to informality over time. Yet, as less workers are making the transition from unemployment to RM formal occupations, one may wonder where do these individuals go upon re-entry into the labour market. It is possible that RM formal workers who have transited to unemployment are finding it difficult to re-join formal labour markets as the polarisation period deepens, and thus are increasingly joining the informal labour markets. We focus our attention on testing this channel.

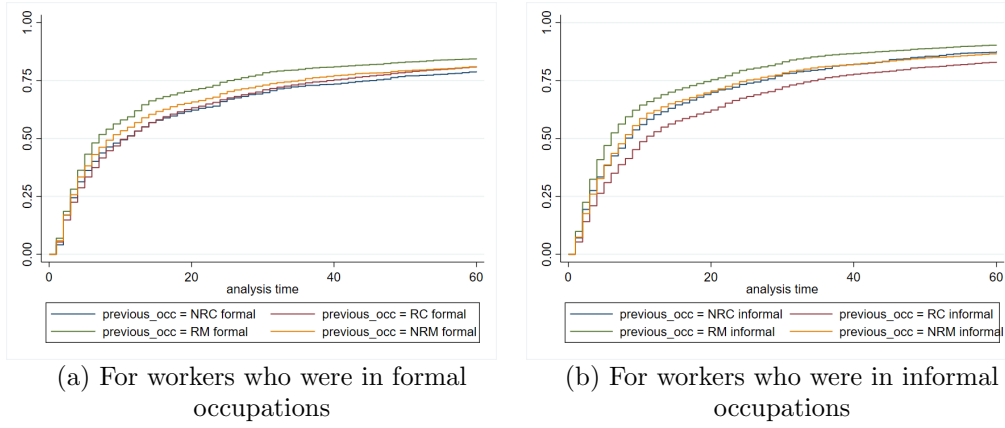
First, we start by analyzing the unemployment spells and more specifically the duration in unemployment for individuals that were previously in RM occupations, as this might influence their decisions of whether to join informal labour markets. The risk of automation is likely to decrease the probability of finding new employment in routine occupations but it might also lead to prolonged unemployment spells or pushed unemployed individuals out of the workforce for good (Schmidpeter and Winter-Ebmer 2021). However, the existing literature finds mixed results. While Schmidpeter and Winter-Ebmer (2021) find that displaced routine workers experience longer periods of unemployment than otherwise identical workers, Bachmann, Cim and Green (2019) find that workers in



more routine-intensive jobs are more likely to become unemployed but do not find an effect on the duration of unemployment.

To investigate this, we examine whether non-employed individuals who were previously RM workers take more time to go back to employment compared to non-employed individuals who were in other occupational categories. Figure 9 shows the probability of non-employed individuals to go back to employment over non-employment duration distinguishing individuals by the last occupation that they occupied. Interestingly, non-employed individuals who were previously working in RM occupations are not remaining out of the labour market for a longer period of time compared to other groups. In both the formal and the informal markets, we do not find significant differences (or only small differences) in terms of how fast individuals re-enter employment.

Figure 9. Probability of employment re-entry for non-employed individuals by previous occupational group



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: Figures 9a and 9b display the probability of going back to employment for individuals who are out of employment, which was obtained by estimating an event history model. We distinguish individuals by their previous occupational group prior to being out of employment. We examine the probability of employment reentries over non-employment duration (in months). We limit the time window to 5 years (x-axis is measured in months).

We now examine whether non-employed individuals who used to be RM workers are more or less likely to re-enter employment in a different occupational group. The results are reported in Table 7. We find that, over time, a larger proportion among individuals who were employed formally in RM occupations and then got non-employed go to informality (Table 7 Panel A). Conversely, a lower proportion of individuals go back to being employed in RM formal occupations, a fact that basically echoes with our result that inflows from unemployment to RM formal occupations have been gradually decreasing.

Similarly, among individuals who were employed informally in RM occupations and then became non-employed (Table 7 Panel B), a higher proportion become employed in other occupations in the informal labour market. In addition, less individuals transit from non-employment to RM informal occupations. Therefore, one of the main results here is that, apart from workers in RM formal employment that directly join informality, we are

finding that another flow of RM formal workers that might have lost their employment due automation first become non-employed before eventually joining the informal labour market.

Table 7. Proportion of individuals transiting to different occupations after having been in RM employment then non-employed

|   | 1980-1990 | 1991-2000 | 2001-2015 |
|---|-----------|-----------|-----------|
| <i>Panel A: For individuals that were in RM formal employment <math>\rightarrow</math> non-emp.</i>   |           |           |           |
| RM formal   | 56.2      | 49.5      | 38.4      |
| RM informal   | 19.1      | 23.7      | 30.5      |
| Other occupations - formal  | 14.2      | 16.7      | 14.4      |
| Other occupations - informal  | 10.5      | 10.2      | 16.7      |
| <i>Panel B: For individuals that were in RM informal employment <math>\rightarrow</math> non-emp.</i> |           |           |           |
| RM formal   | 12.7      | 10.4      | 10.0      |
| RM informal   | 69.4      | 66.7      | 61.6      |
| Other occupations - formal  | 6.8       | 9.2       | 6.3       |
| Other occupations - informal  | 11.2      | 13.6      | 22.0      |

*Source:* Social Protection Survey of Chile, authors' own calculations.

To summarise, we observe that the process of automation has resulted in a displacement of routine workers who have become either unemployed or have experienced a downgrade in their occupational status. While RM formal workers transit to informality in RM or RC occupations, RM informal workers tend to transit more within informal labour markets to NRM occupations. Furthermore, apart from the workers in RM formal occupations that directly join informality, some RM workers go first to non-employment before joining informality.

## 6 Conclusions

In this paper, we analysed the labour market changes that underlie the disappearance of routine jobs and we explored the link between routine-biased technical change and informality in Chile. We first studied individuals' labour market transitions over time using a series of multistate competing risks event history models. We compared the relative risks for individuals to move to different states. We then examined how these relative risks of transiting to different states have changed over time. This allowed us to gain a better understanding of the labour market displacement effects of the process of technological change and its links with informal employment.

In the second part of the paper, we used a modified version of the flow approach adopted in Cortes et al. (2020) to study the flows underlying the decline of routine formal and informal occupations. This allowed us to shed light on which changes in transition rates are key in accounting for the decline in routine employment. We also separated the effects of endogenous transitions of demographic groups and demographic change. We concluded our analysis by examining the outcomes of RM workers who went out of the labour market. More specifically, we examined the risk of going back to employment and the type of employment they are more likely to go back to.

Our results show that the decline in routine occupations is mostly due to a decrease in the share of RM occupations which is observed both in the formal and informal labour market. This implies that the process of technical change might not only affects formal workers, but it also has displacement effects among informal workers. Formal workers employed in RM occupations are more likely to become non-employed or to start to work in the informal sector. This suggests that informality is used as a buffer against job loss for individuals working in routine occupations. Workers employed in RM informal occupations are more likely to become unemployed or to transit to NRM informal occupations. By contrast, the cognitive component of tasks performed by RC workers seems to offer relatively more protection against job displacement and occupational downgrading.

Furthermore, we find clear differences across sociodemographic groups. For instance, regarding workers in RM formal occupations, men are more likely to transit to RM informal occupations whereas women are more likely to become unemployed or inactive. Similarly, among individuals who work in RM informal occupations, women are more likely to become inactive than men. Lastly, our flow approach shows that the decrease in RM occupations can be explained mostly by an increase in outflows and a decrease in inflows from unemployment. Indeed, for RM formal occupations, outflows to unemployment and informality account for an important part of the decline.

This is attributable to endogenous transitions and it is not driven by changes in the demographic composition (rise in educational attainment and population ageing). Thus, for RM formal workers automation is likely to be behind the decrease in its stocks along the period. In the case of RM informal occupations, outflows to unemployment and to NRM informal occupations play an important role in the decrease of RM informal workers. Finally, apart from RM formal workers that join directly the informal labour market after likely being displaced by automation, we have documented the existence of a second channel in which RM workers first become non-employed before eventually joining the informal labour market.

Our study contributes to shed light on the process by which routine employment is disappearing in a middle-income country context where the labour market is characterised by a higher prevalence of underemployment, informality and routine jobs. Our findings also help us to better understand the changing labour market opportunities faced by different demographic groups and to identify vulnerable population groups in order to better assist them in this fast changing job landscape.

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## Appendix A. Construction of the Database

The data we use comes from the Social Protection Survey administered by the Subsecretaría de Previsión Social of Chile. This is a panel dataset currently comprised of seven rounds starting in 2002/2003 up to 2019/2020. However, by the time we conducted the analysis, the 2019/2020 round was not yet available (see Table A.1). The first round of the survey is not representative of the Chilean population (it is only representative of the population affiliated to the pension system). However, the following rounds are representative of the Chilean population aged 18 and above. The labour history section of each round contains retrospective information - workers are asked to recall their labour history - on different labour market outcomes (employment status, occupational category, hours worked, and other) going back to 1980.<sup>9</sup> Combining information from different rounds allows us to reconstruct the full labour market history of individuals from January 1980 to July 2016.<sup>10</sup>

After cleaning each wave, we merge all rounds, except for the 2012/2013 round.<sup>11</sup> During this merge, we detected several inconsistencies. We started by looking at inconsistencies between the start and the end dates of occupational statuses for each individual. We applied an iterative procedure to reduce these conflicts to zero. Generally, we identified the cases where the start date of a status  $j_{t+1}$  was earlier than the end date of the previous status  $j_t$ . In those cases, we substitute the start date of status  $j_{t+1}$  by the end date of status  $j_t$ . Then, we repeat the search for start dates that are higher than the end dates in the same observation. We ran 14 iterations until these conflicts disappear.

In addition, when data is missing between two occupational statuses, we impute the occupational status that is available in the last month before this missing information. We also make a distinction between formal and informal employment. Following [Berniell et al. \(2021\)](#), we define informal workers as: unregistered workers without access to social security benefits, workers with no explicit written contracts of employment, workers in temporary jobs, and low-skilled self-employment. Finally, we restrict our sample to individuals who are 15 to 65 years of age in each occupational status.<sup>12</sup> Our final database contains 27,359 observations spanning from January 1980 to December 2015.<sup>13</sup>

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<sup>9</sup>This is the case for the 2002/2003, 2004/2005 and 2015/2016 rounds. For the other rounds the information on labour market history dates back to the previous round of the survey.

<sup>10</sup>However, our analysis is for the period January 1980 to December 2015.

<sup>11</sup>As documented by [Subsecretaría de Previsión Social \(2012\)](#), the sample design and fieldwork of the 2012/2013 round had several inconsistencies which prevent the extrapolation of the results for the Chilean population aged 18 and above. To avoid adding statistical noise, we decided to exclude this round from our analysis.

<sup>12</sup>Even though the surveys are only representative of individuals aged 18 and above, individuals are asked to recall their labour market history prior to age 18.

<sup>13</sup>Our final panel is not balanced, since we do not restrict our analysis to observations for which we observe the full labour market histories between January 1980 and December 2015.



Table A.1. Description of the rounds of the panel

| Round     | Sample size (individuals) | National representativeness of population aged 18+ | Recalling labour history since   | Variables in labour history module used   |
|-----------|---------------------------|--|--|---|
| 2002/2003 | 17,246                    | No   | (i) January 1980 (or since age 15)   | (i) Start and end (month and year) of the corresponding employment status, (ii) Employment status, (iii) Occupation, (iv) Type of job, (v) Occupational category, (vi) Contractual relationship, (vii) Contributing to the pension system |
| 2004/2005 | 16,727                    | Yes  | (i) January 2002 if interviewed in 2002, (ii) January 1980 (or since age 15) if not interviewed in 2002 (new individuals entering the panel in 2004/05)                                      | (i) Start and end (month and year) of the corresponding employment status, (ii) Employment status, (iii) Occupation, (iv) Type of job, (v) Occupational category, (vi) Contractual relationship, (vii) Contributing to the pension system |
| 2006/2007 | 19,509                    | Yes  | (i) January 2004 if interviewed in 2004/05 (ii) January 2002 if not interviewed in 2004/05   | (i) Start and end (month and year) of the corresponding employment status, (ii) Employment status, (iii) Occupation, (iv) Type of job, (v) Occupational category, (vi) Contractual relationship, (vii) Contributing to the pension system |
| 2008/2009 | 19,512                    | Yes  | (i) January 2006   | (i) Start and end (month and year) of the corresponding employment status, (ii) Employment status, (iii) Occupation, (iv) Type of job, (v) Occupational category, (vi) Contractual relationship, (vii) Contributing to the pension system |
| 2012/2013 | 16,214                    | No   | (i) January 2009   | (i) Start and end (month and year) of the corresponding employment status, (ii) Employment status, (iii) Occupation, (iv) Type of job, (v) Occupational category, (vi) Contractual relationship, (vii) Contributing to the pension system |
| 2015/2016 | 18,007                    | Yes  | (i) January 2009 if individual belongs to the panel sample (ii) January 2001 (or since age 15) if individual belongs to the refreshed sample (new individuals entering the panel in 2015/16) | (i) Start and end (month and year) of the corresponding employment status, (ii) Employment status, (iii) Occupation, (iv) Type of job, (v) Occupational category, (vi) Contractual relationship, (vii) Contributing to the pension system |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: Based on information provided by Subsecretaría de Previsión Social of Chile and [Berniell et al. \(2021\)](#).

## Appendix B. Additional Figures and Tables

Table B.1. Log-relative risks of transiting to different occupations for individuals employed in RM formal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.001***    | 0.001***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 0.155***    | 0.155***      |
| NRC formal x 1990-2000        | 0.415***    | 0.333***      |
| NRC formal x 2000-2010        | 0.801**     | 0.673***      |
| NRC formal x 2010-2020        | 0.574**     | 0.504***      |
| RC formal x 1980-1990         | 0.325***    | 0.327***      |
| RC formal x 1990-2000         | 1.009       | 0.810**       |
| RC formal x 2000-2010         | 1.321***    | 1.122         |
| RC formal x 2010-2020         | 1.385**     | 0.840         |
| NRM formal x 1980-1990        | 0.415***    | 0.416***      |
| NRM formal x 1990-2000        | 1.073       | 0.861         |
| NRM formal x 2000-2010        | 1.636***    | 1.376***      |
| NRM formal x 2010-2020        | 1.115       | 0.773         |
| Unemployment x 1980-1990      | 1.690***    | 1.694***      |
| Unemployment x 1990-2000      | 3.709***    | 2.969***      |
| Unemployment x 2000-2010      | 4.712***    | 3.659***      |
| Unemployment x 2010-2020      | 6.925***    | 3.665***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 1.813***    | 1.451***      |
| Inactivity x 2000-2010        | 1.475***    | 1.185**       |
| Inactivity x 2010-2020        | 3.007***    | 2.051***      |
| NRC informal x 1980-1990      | 0.088***    | 0.088***      |
| NRC informal x 1990-2000      | 0.185***    | 0.149***      |
| NRC informal x 2000-2010      | 0.274***    | 0.229***      |
| NRC informal x 2010-2020      | 0.270***    | 0.168***      |
| RC informal x 1980-1990       | 0.118***    | 0.118***      |
| RC informal x 1990-2000       | 0.345***    | 0.277***      |
| RC informal x 2000-2010       | 0.377***    | 0.302***      |
| RC informal x 2010-2020       | 0.845       | 0.639**       |
| RM informal x 1980-1990       | 1.485***    | 1.488***      |
| RM informal x 1990-2000       | 3.109***    | 2.489***      |
| RM informal x 2000-2010       | 3.717***    | 3.015***      |
| RM informal x 2010-2020       | 2.905***    | 1.580***      |
| NRM informal x 1980-1990      | 0.287***    | 0.288***      |
| NRM informal x 1990-2000      | 0.600***    | 0.482***      |
| NRM informal x 2000-2010      | 0.989       | 0.824**       |
| NRM informal x 2010-2020      | 1.081       | 0.672*        |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 1.452***      |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.899***      |
| 25-29                         |             | 0.737***      |
| 30-34                         |             | 0.618***      |
| 35-39                         |             | 0.510***      |
| 40-44                         |             | 0.502***      |
| 45-49                         |             | 0.457***      |
| 50-54                         |             | 0.348***      |
| 55-59                         |             | 0.240***      |
| 60+                           |             | 0.080***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 0.828***      |
| High                          |             | 1.088         |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.087***      |
| 3+                            |             | 1.089**       |
| Time since in RM              |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 1.341***      |
| 3-5 years                     |             | 1.100**       |
| 5-10 years                    |             | 1.076**       |
| 10+ years                     |             | 1.692***      |
| ln-L                          | -29132.48   | -27248.19     |
| N                             | 421,947     | 390,600       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in RM formal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.2. Log-relative risks of transiting to different occupations for individuals employed in RC formal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.002***    | 0.003***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 0.421***    | 0.421***      |
| NRC formal x 1990-2000        | 0.881*      | 0.684***      |
| NRC formal x 2000-2010        | 1.655***    | 1.328***      |
| NRC formal x 2010-2020        | 0.797*      | 0.576***      |
| RM formal x 1980-1990         | 0.223***    | 0.223***      |
| RM formal x 1990-2000         | 0.476***    | 0.370***      |
| RM formal x 2000-2010         | 0.702***    | 0.555***      |
| RM formal x 2010-2020         | 0.682***    | 0.459***      |
| NRM formal x 1980-1990        | 0.175***    | 0.175***      |
| NRM formal x 1990-2000        | 0.369***    | 0.283***      |
| NRM formal x 2000-2010        | 0.707***    | 0.559***      |
| NRM formal x 2010-2020        | 0.531***    | 0.331***      |
| Unemployment x 1980-1990      | 0.860**     | 0.859**       |
| Unemployment x 1990-2000      | 2.154***    | 1.660***      |
| Unemployment x 2000-2010      | 2.513***    | 1.887***      |
| Unemployment x 2010-2020      | 4.402***    | 2.357***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 1.690***    | 1.310***      |
| Inactivity x 2000-2010        | 1.723***    | 1.317***      |
| Inactivity x 2010-2020        | 4.263***    | 2.602***      |
| NRC informal x 1980-1990      | 0.103***    | 0.103***      |
| NRC informal x 1990-2000      | 0.173***    | 0.133***      |
| NRC informal x 2000-2010      | 0.303***    | 0.234***      |
| NRC informal x 2010-2020      | 0.370***    | 0.224***      |
| RC informal x 1980-1990       | 0.347***    | 0.347***      |
| RC informal x 1990-2000       | 0.730***    | 0.569***      |
| RC informal x 2000-2010       | 0.877*      | 0.692***      |
| RC informal x 2010-2020       | 1.271**     | 0.821         |
| RM informal x 1980-1990       | 0.161***    | 0.159***      |
| RM informal x 1990-2000       | 0.241***    | 0.187***      |
| RM informal x 2000-2010       | 0.347***    | 0.267***      |
| RM informal x 2010-2020       | 0.381***    | 0.203***      |
| NRM informal x 1980-1990      | 0.087***    | 0.087***      |
| NRM informal x 1990-2000      | 0.187***    | 0.144***      |
| NRM informal x 2000-2010      | 0.322***    | 0.245***      |
| NRM informal x 2010-2020      | 0.497***    | 0.288***      |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 0.958**       |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.879***      |
| 25-29                         |             | 0.670***      |
| 30-34                         |             | 0.563***      |
| 35-39                         |             | 0.462***      |
| 40-44                         |             | 0.452***      |
| 45-49                         |             | 0.358***      |
| 50-54                         |             | 0.265***      |
| 55-59                         |             | 0.193***      |
| 60+                           |             | 0.082***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 0.784***      |
| High                          |             | 1.100*        |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.009         |
| 3+                            |             | 0.943         |
| Time since in RC              |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 1.310***      |
| 3-5 years                     |             | 1.132***      |
| 5-10 years                    |             | 1.100**       |
| 10+ years                     |             | 1.618***      |
| ln-L                          | -34067.51   | -31432.06     |
| N                             | 446,895     | 407,493       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in RC formal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.3. Log-relative risks of transiting to different occupations for individuals employed in NRM formal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.002***    | 0.003***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 0.044***    | 0.044***      |
| NRC formal x 1990-2000        | 0.146***    | 0.107***      |
| NRC formal x 2000-2010        | 0.284***    | 0.210***      |
| NRC formal x 2010-2020        | 0.287***    | 0.129***      |
| RC formal x 1980-1990         | 0.302***    | 0.302***      |
| RC formal x 1990-2000         | 1.009       | 0.741***      |
| RC formal x 2000-2010         | 1.366***    | 0.990         |
| RC formal x 2010-2020         | 1.306*      | 0.794         |
| RM formal x 1980-1990         | 0.533***    | 0.533***      |
| RM formal x 1990-2000         | 1.016       | 0.746***      |
| RM formal x 2000-2010         | 1.471***    | 1.064         |
| RM formal x 2010-2020         | 1.123       | 0.666**       |
| Unemployment x 1980-1990      | 0.971       | 0.971         |
| Unemployment x 1990-2000      | 2.584***    | 1.897***      |
| Unemployment x 2000-2010      | 2.748***    | 1.846***      |
| Unemployment x 2010-2020      | 3.683***    | 1.589***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 1.784***    | 1.305***      |
| Inactivity x 2000-2010        | 1.396***    | 0.975         |
| Inactivity x 2010-2020        | 2.847***    | 1.610***      |
| NRC informal x 1980-1990      | 0.032***    | 0.032***      |
| NRC informal x 1990-2000      | 0.083***    | 0.061***      |
| NRC informal x 2000-2010      | 0.055***    | 0.041***      |
| NRC informal x 2010-2020      | 0.209***    | 0.129***      |
| RC informal x 1980-1990       | 0.108***    | 0.108***      |
| RC informal x 1990-2000       | 0.279***    | 0.205***      |
| RC informal x 2000-2010       | 0.364***    | 0.255***      |
| RC informal x 2010-2020       | 0.653**     | 0.408***      |
| RM informal x 1980-1990       | 0.275***    | 0.275***      |
| RM informal x 1990-2000       | 0.629***    | 0.461***      |
| RM informal x 2000-2010       | 0.888       | 0.639***      |
| RM informal x 2010-2020       | 0.522***    | 0.150***      |
| NRM informal x 1980-1990      | 0.501***    | 0.501***      |
| NRM informal x 1990-2000      | 1.225*      | 0.895         |
| NRM informal x 2000-2010      | 1.591***    | 1.134         |
| NRM informal x 2010-2020      | 1.724***    | 0.709**       |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 0.952*        |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.833***      |
| 25-29                         |             | 0.622***      |
| 30-34                         |             | 0.565***      |
| 35-39                         |             | 0.498***      |
| 40-44                         |             | 0.394***      |
| 45-49                         |             | 0.393***      |
| 50-54                         |             | 0.323***      |
| 55-59                         |             | 0.169***      |
| 60+                           |             | 0.046***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 1.096***      |
| High                          |             | 1.472***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.037         |
| 3+                            |             | 1.068         |
| Time since in NRM             |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 1.268***      |
| 3-5 years                     |             | 0.995         |
| 5-10 years                    |             | 0.932         |
| 10+ years                     |             | 1.429***      |
| ln-L                          | -20274.11   | -18788.93     |
| N                             | 246,348     | 228,679       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in NRM formal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.4. Log-relative risks of transiting to different occupations for individuals employed in NRC formal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.001***    | 0.002***      |
| Type x Period                 |             |               |
| RC formal x 1980-1990         | 0.681***    | 0.681***      |
| RC formal x 1990-2000         | 2.190***    | 1.745***      |
| RC formal x 2000-2010         | 3.860***    | 3.010***      |
| RC formal x 2010-2020         | 1.470**     | 0.872         |
| RM formal x 1980-1990         | 0.156***    | 0.156***      |
| RM formal x 1990-2000         | 0.495***    | 0.394***      |
| RM formal x 2000-2010         | 1.113       | 0.861         |
| RM formal x 2010-2020         | 0.531**     | 0.379***      |
| NRM formal x 1980-1990        | 0.054***    | 0.054***      |
| NRM formal x 1990-2000        | 0.074***    | 0.059***      |
| NRM formal x 2000-2010        | 0.363***    | 0.285***      |
| NRM formal x 2010-2020        | 0.286***    | 0.152***      |
| Unemployment x 1980-1990      | 0.669***    | 0.669***      |
| Unemployment x 1990-2000      | 2.317***    | 1.837***      |
| Unemployment x 2000-2010      | 2.532***    | 1.819***      |
| Unemployment x 2010-2020      | 4.980***    | 3.147***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 1.495***    | 1.191         |
| Inactivity x 2000-2010        | 1.749***    | 1.327***      |
| Inactivity x 2010-2020        | 3.674***    | 2.464***      |
| NRC informal x 1980-1990      | 0.669***    | 0.669***      |
| NRC informal x 1990-2000      | 1.369***    | 1.082         |
| NRC informal x 2000-2010      | 1.460***    | 1.120         |
| NRC informal x 2010-2020      | 1.674***    | 1.137         |
| RC informal x 1980-1990       | 0.128***    | 0.128***      |
| RC informal x 1990-2000       | 0.390***    | 0.310***      |
| RC informal x 2000-2010       | 0.495***    | 0.369***      |
| RC informal x 2010-2020       | 0.490**     | 0.379***      |
| RM informal x 1980-1990       | 0.117***    | 0.117***      |
| RM informal x 1990-2000       | 0.305***    | 0.243***      |
| RM informal x 2000-2010       | 0.421***    | 0.330***      |
| RM informal x 2010-2020       | 0.408***    | 0.191***      |
| NRM informal x 1980-1990      | 0.058***    | 0.058***      |
| NRM informal x 1990-2000      | 0.147***    | 0.117***      |
| NRM informal x 2000-2010      | 0.272***    | 0.201***      |
| NRM informal x 2010-2020      | 0.204***    | 0.152***      |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 0.932**       |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.970         |
| 25-29                         |             | 0.843***      |
| 30-34                         |             | 0.793***      |
| 35-39                         |             | 0.697***      |
| 40-44                         |             | 0.593***      |
| 45-49                         |             | 0.490***      |
| 50-54                         |             | 0.433***      |
| 55-59                         |             | 0.306***      |
| 60+                           |             | 0.137***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 0.733***      |
| High                          |             | 0.393***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.011         |
| 3+                            |             | 1.209*        |
| Time since in NRC             |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 1.587***      |
| 3-5 years                     |             | 1.075         |
| 5-10 years                    |             | 1.038         |
| 10+ years                     |             | 1.881***      |
| ln-L                          | -14255.59   | -13272.42     |
| N                             | 272,430     | 257,634       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in NRC formal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.5. Log-relative risks of transiting to different occupations for individuals employed in RM informal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.002***    | 0.005***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 0.042***    | 0.042***      |
| NRC formal x 1990-2000        | 0.180***    | 0.100***      |
| NRC formal x 2000-2010        | 0.266***    | 0.118***      |
| NRC formal x 2010-2020        | 0.310***    | 0.082***      |
| RC formal x 1980-1990         | 0.182***    | 0.182***      |
| RC formal x 1990-2000         | 0.498***    | 0.276***      |
| RC formal x 2000-2010         | 0.573***    | 0.248***      |
| RC formal x 2010-2020         | 1.210       | 0.422***      |
| RM formal x 1980-1990         | 0.996       | 0.995         |
| RM formal x 1990-2000         | 2.471***    | 1.364***      |
| RM formal x 2000-2010         | 3.509***    | 1.515***      |
| RM formal x 2010-2020         | 3.971***    | 1.104         |
| NRM formal x 1980-1990        | 0.231***    | 0.231***      |
| NRM formal x 1990-2000        | 0.552***    | 0.302***      |
| NRM formal x 2000-2010        | 0.712***    | 0.310***      |
| NRM formal x 2010-2020        | 0.775       | 0.218***      |
| Unemployment x 1980-1990      | 1.735***    | 1.734***      |
| Unemployment x 1990-2000      | 5.499***    | 3.036***      |
| Unemployment x 2000-2010      | 8.713***    | 3.715***      |
| Unemployment x 2010-2020      | 11.446***   | 2.984***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 3.187***    | 1.763***      |
| Inactivity x 2000-2010        | 3.407***    | 1.479***      |
| Inactivity x 2010-2020        | 6.979***    | 2.207***      |
| NRC informal x 1980-1990      | 0.113***    | 0.113***      |
| NRC informal x 1990-2000      | 0.302***    | 0.167***      |
| NRC informal x 2000-2010      | 0.418***    | 0.182***      |
| NRC informal x 2010-2020      | 0.527**     | 0.163***      |
| RC informal x 1980-1990       | 0.182***    | 0.182***      |
| RC informal x 1990-2000       | 0.472***    | 0.261***      |
| RC informal x 2000-2010       | 0.516***    | 0.228***      |
| RC informal x 2010-2020       | 1.520***    | 0.354***      |
| NRM informal x 1980-1990      | 0.566***    | 0.564***      |
| NRM informal x 1990-2000      | 1.405***    | 0.774**       |
| NRM informal x 2000-2010      | 2.584***    | 1.133*        |
| NRM informal x 2010-2020      | 3.784***    | 1.172         |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 1.848***      |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.833***      |
| 25-29                         |             | 0.632***      |
| 30-34                         |             | 0.554***      |
| 35-39                         |             | 0.535***      |
| 40-44                         |             | 0.483***      |
| 45-49                         |             | 0.395***      |
| 50-54                         |             | 0.265***      |
| 55-59                         |             | 0.185***      |
| 60+                           |             | 0.077***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 0.956*        |
| High                          |             | 1.483***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.265***      |
| 3+                            |             | 1.689***      |
| Time since in RM              |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 0.513***      |
| 3-5 years                     |             | 0.342***      |
| 5-10 years                    |             | 0.311***      |
| 10+ years                     |             | 0.489***      |
| ln-L                          | -44841.06   | -40126.87     |
| N                             | 399,438     | 376,164       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in RM informal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.6. Log-relative risks of transiting to different occupations for individuals employed in RC informal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.003***    | 0.008***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 0.098***    | 0.098***      |
| NRC formal x 1990-2000        | 0.245***    | 0.147***      |
| NRC formal x 2000-2010        | 0.373***    | 0.196***      |
| NRC formal x 2010-2020        | 0.440***    | 0.177***      |
| RC formal x 1980-1990         | 0.610***    | 0.610***      |
| RC formal x 1990-2000         | 1.754***    | 1.047         |
| RC formal x 2000-2010         | 1.837***    | 0.968         |
| RC formal x 2010-2020         | 2.187***    | 0.739***      |
| RM formal x 1980-1990         | 0.216***    | 0.216***      |
| RM formal x 1990-2000         | 0.282***    | 0.169***      |
| RM formal x 2000-2010         | 0.292***    | 0.151***      |
| RM formal x 2010-2020         | 0.259***    | 0.095***      |
| NRM formal x 1980-1990        | 0.115***    | 0.115***      |
| NRM formal x 1990-2000        | 0.261***    | 0.156***      |
| NRM formal x 2000-2010        | 0.420***    | 0.218***      |
| NRM formal x 2010-2020        | 0.362***    | 0.136***      |
| Unemployment x 1980-1990      | 0.725***    | 0.725***      |
| Unemployment x 1990-2000      | 2.365***    | 1.416***      |
| Unemployment x 2000-2010      | 3.267***    | 1.666***      |
| Unemployment x 2010-2020      | 5.539***    | 1.731***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 3.128***    | 1.863***      |
| Inactivity x 2000-2010        | 3.229***    | 1.688***      |
| Inactivity x 2010-2020        | 9.512***    | 3.433***      |
| NRC informal x 1980-1990      | 0.154***    | 0.154***      |
| NRC informal x 1990-2000      | 0.292***    | 0.175***      |
| NRC informal x 2000-2010      | 0.812**     | 0.429***      |
| NRC informal x 2010-2020      | 0.699**     | 0.260***      |
| RM informal x 1980-1990       | 0.239***    | 0.239***      |
| RM informal x 1990-2000       | 0.402***    | 0.241***      |
| RM informal x 2000-2010       | 0.561***    | 0.290***      |
| RM informal x 2010-2020       | 0.647**     | 0.213***      |
| NRM informal x 1980-1990      | 0.306***    | 0.306***      |
| NRM informal x 1990-2000      | 0.465***    | 0.278***      |
| NRM informal x 2000-2010      | 0.759***    | 0.396***      |
| NRM informal x 2010-2020      | 1.229       | 0.384***      |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 1.019         |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.761***      |
| 25-29                         |             | 0.609***      |
| 30-34                         |             | 0.513***      |
| 35-39                         |             | 0.489***      |
| 40-44                         |             | 0.459***      |
| 45-49                         |             | 0.392***      |
| 50-54                         |             | 0.238***      |
| 55-59                         |             | 0.243***      |
| 60+                           |             | 0.032***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 1.240***      |
| High                          |             | 1.843***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.079**       |
| 3+                            |             | 1.300***      |
| Time since in RC              |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 0.593***      |
| 3-5 years                     |             | 0.463***      |
| 5-10 years                    |             | 0.369***      |
| 10+ years                     |             | 0.474***      |
| ln-L                          | -31346.44   | -28165.26     |
| N                             | 222,147     | 205,929       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in RC informal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.7. Log-relative risks of transiting to different occupations for individuals employed in NRM informal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.005***    | 0.015***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 0.012***    | 0.012***      |
| NRC formal x 1990-2000        | 0.017***    | 0.009***      |
| NRC formal x 2000-2010        | 0.040***    | 0.018***      |
| NRC formal x 2010-2020        | 0.173***    | 0.054***      |
| RC formal x 1980-1990         | 0.098***    | 0.098***      |
| RC formal x 1990-2000         | 0.212***    | 0.105***      |
| RC formal x 2000-2010         | 0.245***    | 0.106***      |
| RC formal x 2010-2020         | 0.685**     | 0.194***      |
| RM formal x 1980-1990         | 0.146***    | 0.146***      |
| RM formal x 1990-2000         | 0.256***    | 0.126***      |
| RM formal x 2000-2010         | 0.416***    | 0.185***      |
| RM formal x 2010-2020         | 0.399***    | 0.087***      |
| NRM formal x 1980-1990        | 0.238***    | 0.238***      |
| NRM formal x 1990-2000        | 0.471***    | 0.232***      |
| NRM formal x 2000-2010        | 0.736***    | 0.321***      |
| NRM formal x 2010-2020        | 0.572***    | 0.157***      |
| Unemployment x 1980-1990      | 1.040       | 1.040         |
| Unemployment x 1990-2000      | 3.443***    | 1.699***      |
| Unemployment x 2000-2010      | 3.422***    | 1.487***      |
| Unemployment x 2010-2020      | 5.320***    | 1.375***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 2.798***    | 1.379***      |
| Inactivity x 2000-2010        | 2.032***    | 0.897*        |
| Inactivity x 2010-2020        | 5.823***    | 1.740***      |
| NRC informal x 1980-1990      | 0.019***    | 0.019***      |
| NRC informal x 1990-2000      | 0.058***    | 0.029***      |
| NRC informal x 2000-2010      | 0.084***    | 0.036***      |
| NRC informal x 2010-2020      | 0.182***    | 0.057***      |
| RC informal x 1980-1990       | 0.134***    | 0.134***      |
| RC informal x 1990-2000       | 0.329***    | 0.162***      |
| RC informal x 2000-2010       | 0.388***    | 0.169***      |
| RC informal x 2010-2020       | 0.840       | 0.194***      |
| RM informal x 1980-1990       | 0.303***    | 0.303***      |
| RM informal x 1990-2000       | 0.707***    | 0.347***      |
| RM informal x 2000-2010       | 0.907       | 0.397***      |
| RM informal x 2010-2020       | 1.074       | 0.268***      |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 1.144***      |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.761***      |
| 25-29                         |             | 0.707***      |
| 30-34                         |             | 0.682***      |
| 35-39                         |             | 0.661***      |
| 40-44                         |             | 0.529***      |
| 45-49                         |             | 0.419***      |
| 50-54                         |             | 0.333***      |
| 55-59                         |             | 0.217***      |
| 60+                           |             | 0.031***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 1.066***      |
| High                          |             | 1.868***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.356***      |
| 3+                            |             | 1.979***      |
| Time since in NRM             |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 0.446***      |
| 3-5 years                     |             | 0.301***      |
| 5-10 years                    |             | 0.229***      |
| 10+ years                     |             | 0.297***      |
| ln-L                          | -47699.54   | -41787.94     |
| N                             | 334,800     | 313,594       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in NRM informal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .



Table B.8. Log-relative risks of transiting to different occupations for individuals employed in NRC informal occupations

|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.001***    | 0.003***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990        | 1.505***    | 1.505***      |
| NRC formal x 1990-2000        | 3.617***    | 2.388***      |
| NRC formal x 2000-2010        | 4.306***    | 2.306***      |
| NRC formal x 2010-2020        | 4.669***    | 1.864***      |
| RC formal x 1980-1990         | 0.376***    | 0.376***      |
| RC formal x 1990-2000         | 0.990       | 0.654**       |
| RC formal x 2000-2010         | 1.652***    | 0.879         |
| RC formal x 2010-2020         | 2.043***    | 0.919         |
| RM formal x 1980-1990         | 0.183***    | 0.183***      |
| RM formal x 1990-2000         | 0.546***    | 0.360***      |
| RM formal x 2000-2010         | 0.715*      | 0.387***      |
| RM formal x 2010-2020         | 0.525*      | 0.157***      |
| NRM formal x 1980-1990        | 0.065***    | 0.065***      |
| NRM formal x 1990-2000        | 0.121***    | 0.080***      |
| NRM formal x 2000-2010        | 0.247***    | 0.134***      |
| NRM formal x 2010-2020        | 0.525*      | 0.157***      |
| Unemployment x 1980-1990      | 0.785       | 0.785         |
| Unemployment x 1990-2000      | 2.506***    | 1.654***      |
| Unemployment x 2000-2010      | 5.138***    | 2.693***      |
| Unemployment x 2010-2020      | 11.497***   | 4.226***      |
| Inactivity x 1980-1990 (ref.) | 1           | 1             |
| Inactivity x 1990-2000        | 2.930***    | 1.934***      |
| Inactivity x 2000-2010        | 4.384***    | 2.327***      |
| Inactivity x 2010-2020        | 11.439***   | 4.200***      |
| RC informal x 1980-1990       | 0.634***    | 0.634***      |
| RC informal x 1990-2000       | 1.172       | 0.774         |
| RC informal x 2000-2010       | 2.211***    | 1.195         |
| RC informal x 2010-2020       | 2.043***    | 0.735         |
| RM informal x 1980-1990       | 0.495***    | 0.495***      |
| RM informal x 1990-2000       | 0.929       | 0.614**       |
| RM informal x 2000-2010       | 1.236       | 0.661**       |
| RM informal x 2010-2020       | 1.051       | 0.262***      |
| NRM informal x 1980-1990      | 0.140***    | 0.140***      |
| NRM informal x 1990-2000      | 0.343***    | 0.227***      |
| NRM informal x 2000-2010      | 0.507***    | 0.274***      |
| NRM informal x 2010-2020      | 0.584       | 0.236***      |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 1.193***      |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.857**       |
| 25-29                         |             | 0.622***      |
| 30-34                         |             | 0.492***      |
| 35-39                         |             | 0.436***      |
| 40-44                         |             | 0.419***      |
| 45-49                         |             | 0.418***      |
| 50-54                         |             | 0.329***      |
| 55-59                         |             | 0.078***      |
| 60+                           |             | 0.033***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 1.208**       |
| High                          |             | 1.255***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 1.080         |
| 3+                            |             | 1.449***      |
| Time since in NRC             |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 0.657***      |
| 3-5 years                     |             | 0.402***      |
| 5-10 years                    |             | 0.394***      |
| 10+ years                     |             | 0.746***      |
| ln-L                          | -13108.81   | -12094.06     |
| N                             | 121,383     | 114,633       |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals employed in NRC informal occupations.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

Table B.9. Log-relative risks of transiting to different occupations for individuals who are out of employment

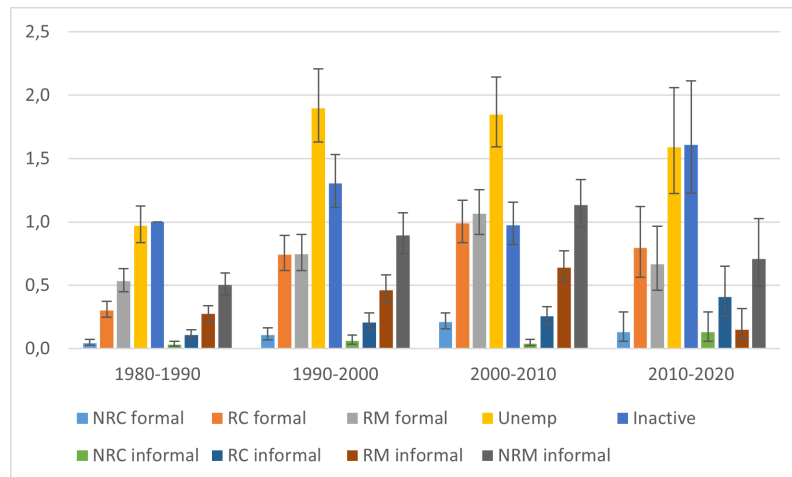
|                               | No controls | With controls |
|-------------------------------|-------------|---------------|
| Constant                      | 0.001***    | 0.003***      |
| Type x Period                 |             |               |
| NRC formal x 1980-1990 (ref.) | 1           | 1             |
| NRC formal x 1990-2000        | 2.141***    | 0.830***      |
| NRC formal x 2000-2010        | 2.333***    | 0.796***      |
| NRC formal x 2010-2020        | 3.687***    | 0.998         |
| RC formal x 1980-1990         | 2.045***    | 2.045***      |
| RC formal x 1990-2000         | 6.452***    | 2.501***      |
| RC formal x 2000-2010         | 5.417***    | 1.847***      |
| RC formal x 2010-2020         | 9.608***    | 2.252***      |
| RM formal x 1980-1990         | 1.591***    | 1.591***      |
| RM formal x 1990-2000         | 3.947***    | 1.533***      |
| RM formal x 2000-2010         | 3.784***    | 1.290***      |
| RM formal x 2010-2020         | 4.357***    | 0.945         |
| NRM formal x 1980-1990        | 1.183***    | 1.183***      |
| NRM formal x 1990-2000        | 2.805***    | 1.088         |
| NRM formal x 2000-2010        | 2.615***    | 0.885**       |
| NRM formal x 2010-2020        | 3.401***    | 0.747***      |
| Unemployment x 1980-1990      | 1.583***    | 1.581***      |
| Unemployment x 1990-2000      | 3.854***    | 1.494***      |
| Unemployment x 2000-2010      | 2.929***    | 1.012         |
| Unemployment x 2010-2020      | 1.527***    | 0.264***      |
| Inactivity x 1980-1990        | 0.267***    | 0.267***      |
| Inactivity x 1990-2000        | 0.977       | 0.380***      |
| Inactivity x 2000-2010        | 2.455***    | 0.865***      |
| Inactivity x 2010-2020        | 0.683***    | 0.181***      |
| NRC informal x 1980-1990      | 0.616***    | 0.616***      |
| NRC informal x 1990-2000      | 1.832***    | 0.712         |
| NRC informal x 2000-2010      | 2.617***    | 0.905*        |
| NRC informal x 2010-2020      | 4.630***    | 1.262***      |
| RC informal x 1980-1990       | 1.594***    | 1.592***      |
| RC informal x 1990-2000       | 5.491***    | 2.126***      |
| RC informal x 2000-2010       | 6.520***    | 2.201***      |
| RC informal x 2010-2020       | 11.980***   | 2.813***      |
| RM informal x 1980-1990       | 2.388***    | 2.388***      |
| RM informal x 1990-2000       | 7.146***    | 2.769***      |
| RM informal x 2000-2010       | 8.898***    | 3.047***      |
| RM informal x 2010-2020       | 7.647***    | 1.588***      |
| NRM informal x 1980-1990      | 3.145***    | 3.145***      |
| NRM informal x 1990-2000      | 9.591***    | 3.722***      |
| NRM informal x 2000-2010      | 10.489***   | 3.592***      |
| NRM informal x 2010-2020      | 13.693***   | 3.254***      |
| Sex                           |             |               |
| Male (ref.)                   |             | 1             |
| Female                        |             | 0.546***      |
| Age group                     |             |               |
| 16-19 (ref.)                  |             | 1             |
| 20-24                         |             | 0.756***      |
| 25-29                         |             | 0.643***      |
| 30-34                         |             | 0.562***      |
| 35-39                         |             | 0.483***      |
| 40-44                         |             | 0.396***      |
| 45-49                         |             | 0.291***      |
| 50-54                         |             | 0.161***      |
| 55-59                         |             | 0.099***      |
| 60+                           |             | 0.013***      |
| Educational level             |             |               |
| Low (ref.)                    |             | 1             |
| Medium                        |             | 0.911***      |
| High                          |             | 0.721***      |
| Order of transition           |             |               |
| 1 (ref.)                      |             | 1             |
| 2                             |             | 2.219***      |
| 3+                            |             | 3.352***      |
| Time since out of employment  |             |               |
| 0-1 year (ref.)               |             | 1             |
| 1-3 years                     |             | 0.511***      |
| 3-5 years                     |             | 0.614***      |
| 5-10 years                    |             | 0.518***      |
| 10+ years                     |             | 0.500***      |
| ln-L                          | -184484.85  | -161574.51    |
| N                             | 1,599,700   | 1,516,345     |

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: this table presents the log-relative risks of transiting to different occupations for individuals who are out of employment.

\*  $p < 0.10$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ .

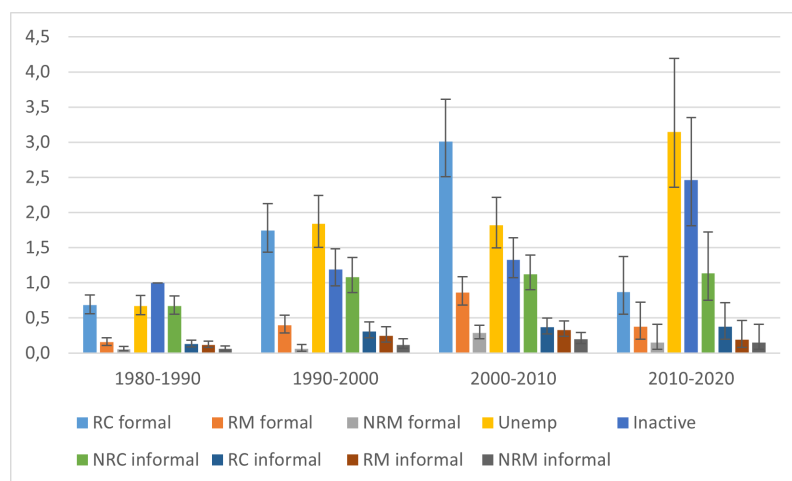
Figure B.1. Relative risks of a transition by type of transition over time for NRM formal workers



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for NRM formal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transitioning to inactivity in the 1980s. 95% confidence intervals are also reported.

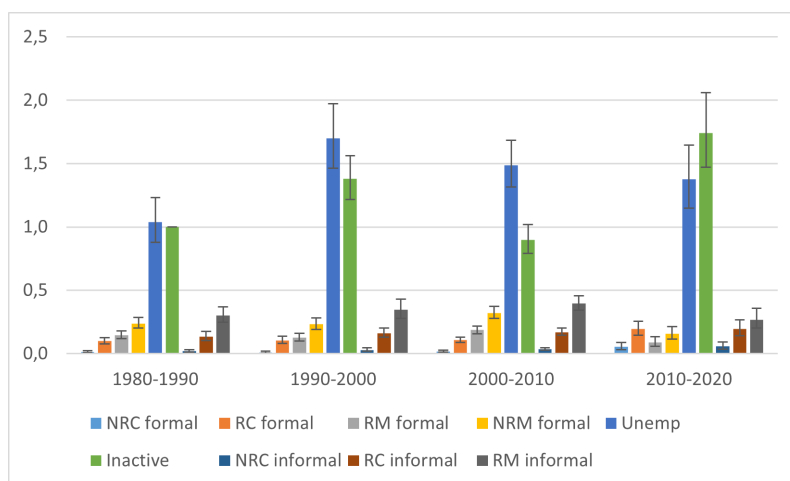
Figure B.2. Relative risks of a transition by type of transition over time for NRC formal workers



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for NRC formal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transitioning to inactivity in the 1980s. 95% confidence intervals are also reported.

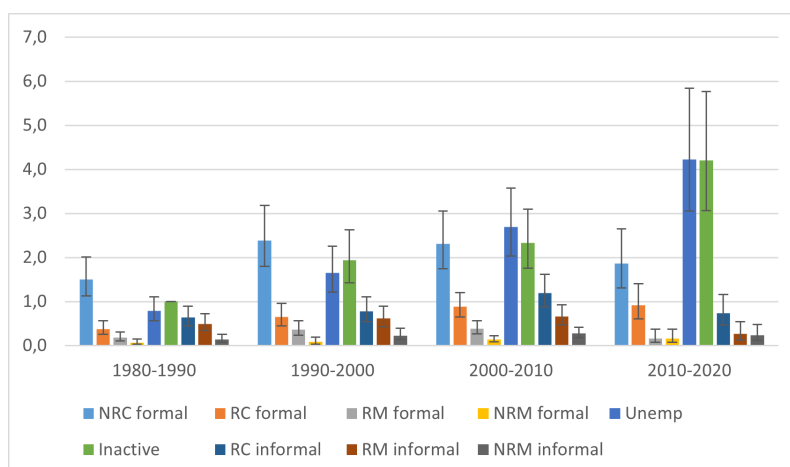
Figure B.3. Relative risks of a transition by type of transition over time for NRM informal workers



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for NRM informal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

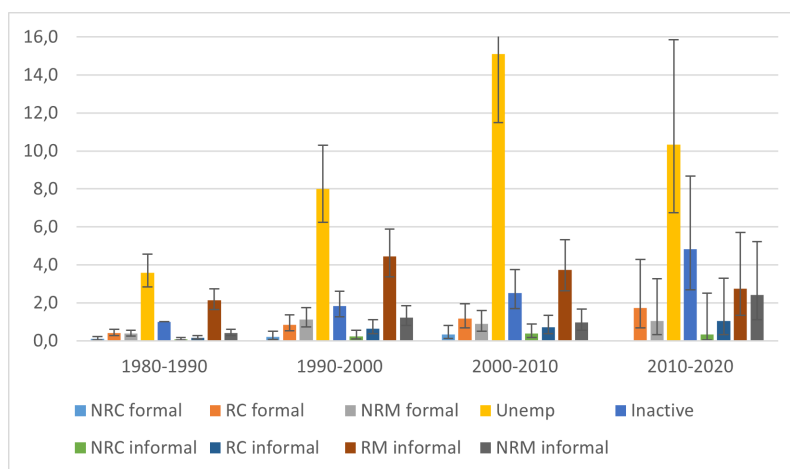
Figure B.4. Relative risks of a transition by type of transition over time for NRC informal workers



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for NRC informal workers. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

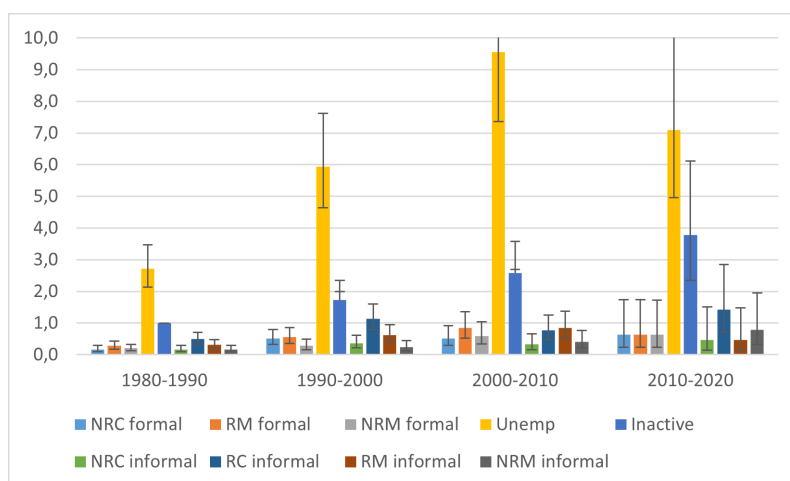
Figure B.5. Relative risks of a transition by type of transition over time for RM formal workers who lost their job unvoluntarily



Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for RM formal workers who lost their job unvoluntarily, e.g. they have either been dismissed due to the company needs or due to a closure of the company. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

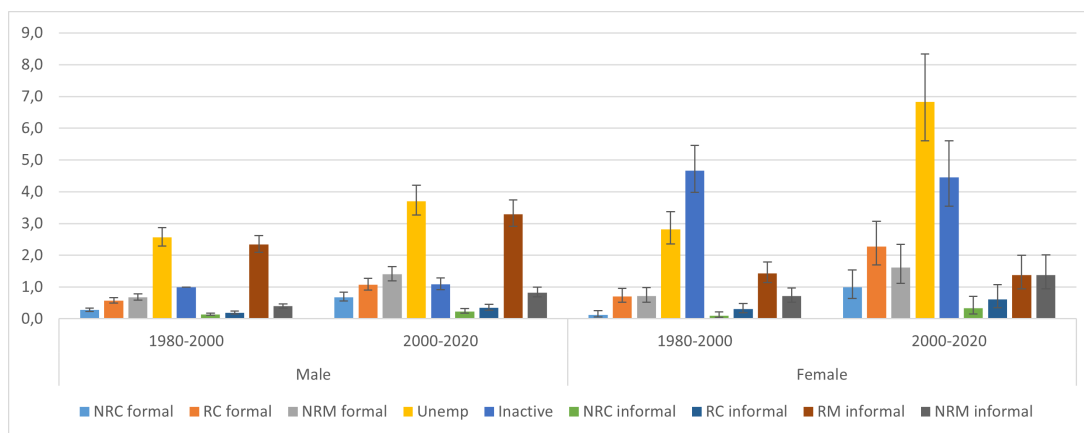
Figure B.6. Relative risks of a transition by type of transition over time for RC formal workers who lost their job unvoluntarily



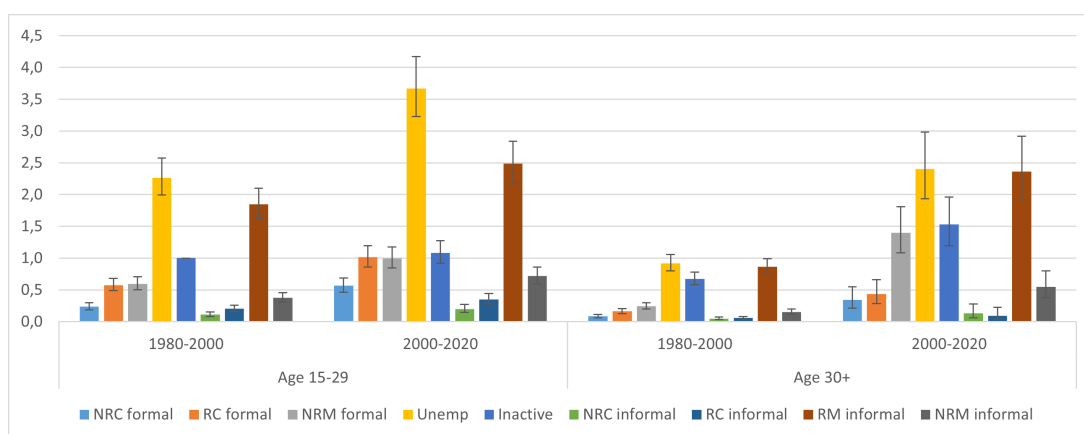
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition by type of transition over time for RC formal workers who lost their job unvoluntarily, e.g. they have either been dismissed due to the company needs or due to a closure of the company. All the models are adjusted for sex, age, level of education, and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported.

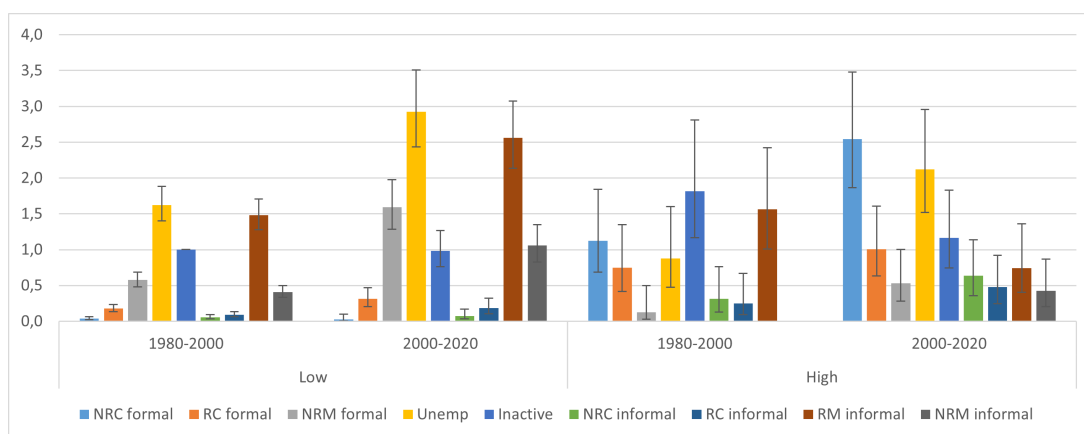
Figure B.7. Relative risks of a transition by type of transition over time for RM formal workers



(a) By sex



(b) By age group

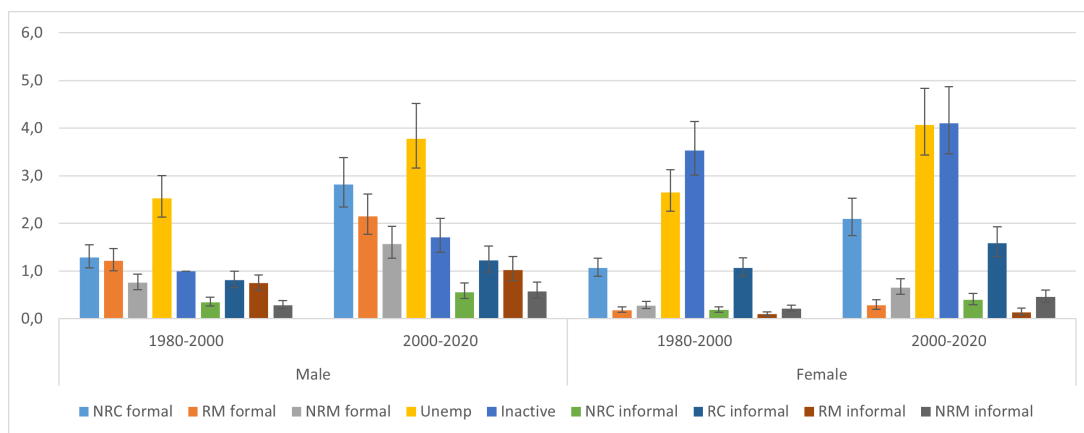


(c) By educational level

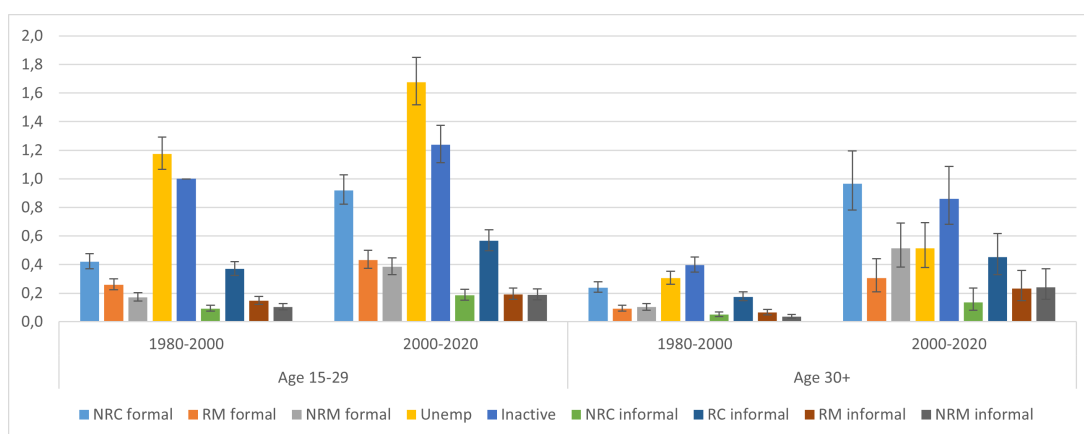
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for RM formal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

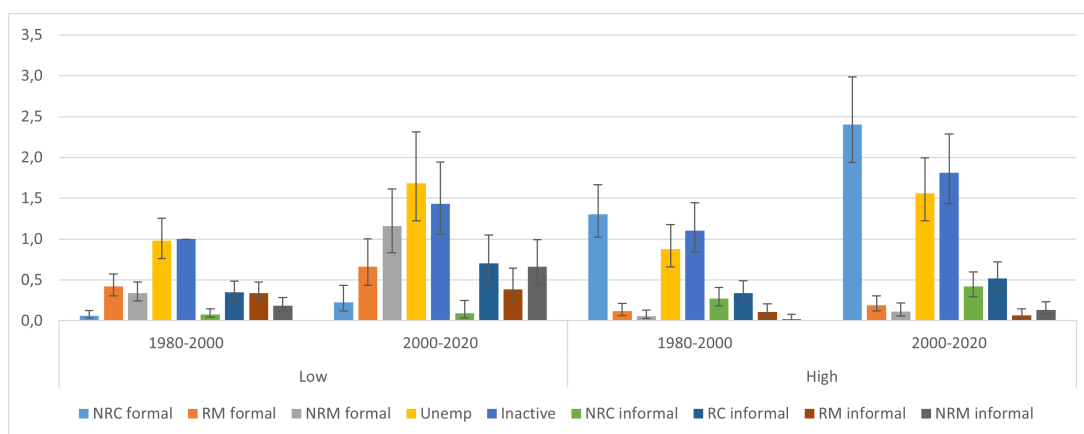
Figure B.8. Relative risks of a transition by type of transition over time for RC formal workers



(a) By sex



(b) By age group

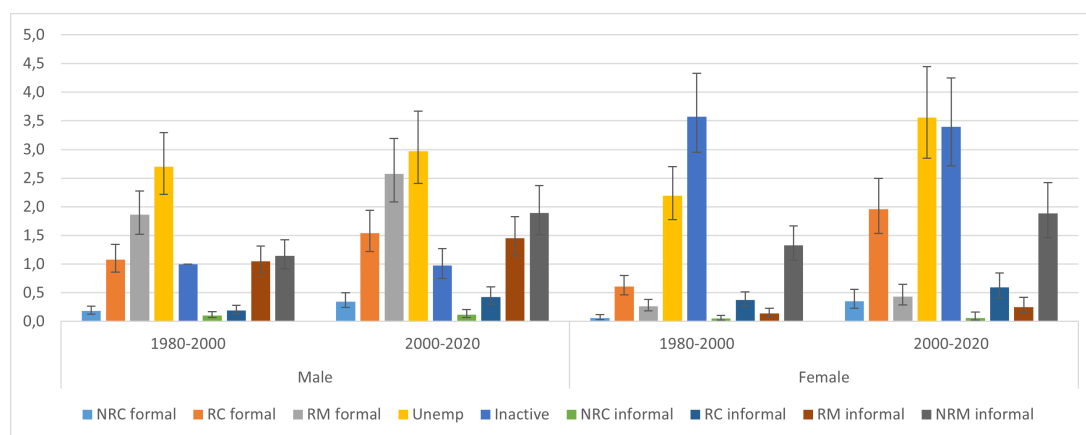


(c) By educational level

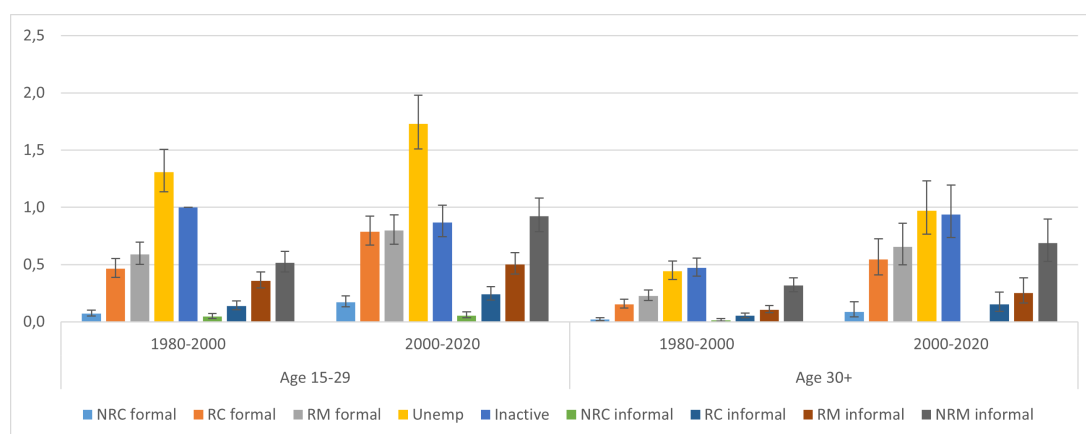
*Source:* Social Protection Survey of Chile, authors' own calculations.

*Notes:* The figure presents the relative risks of a transition over time for RC formal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

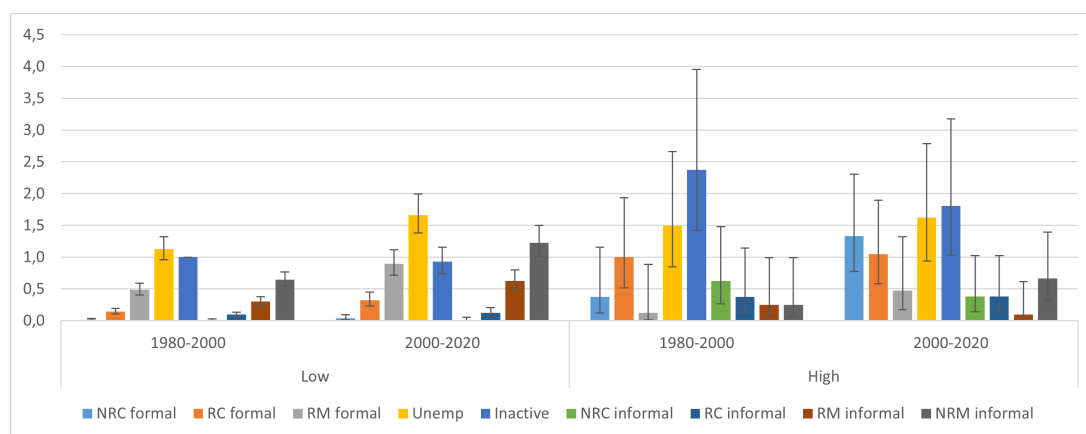
Figure B.9. Relative risks of a transition by type of transition over time for NRM formal workers



(a) By sex



(b) By age group



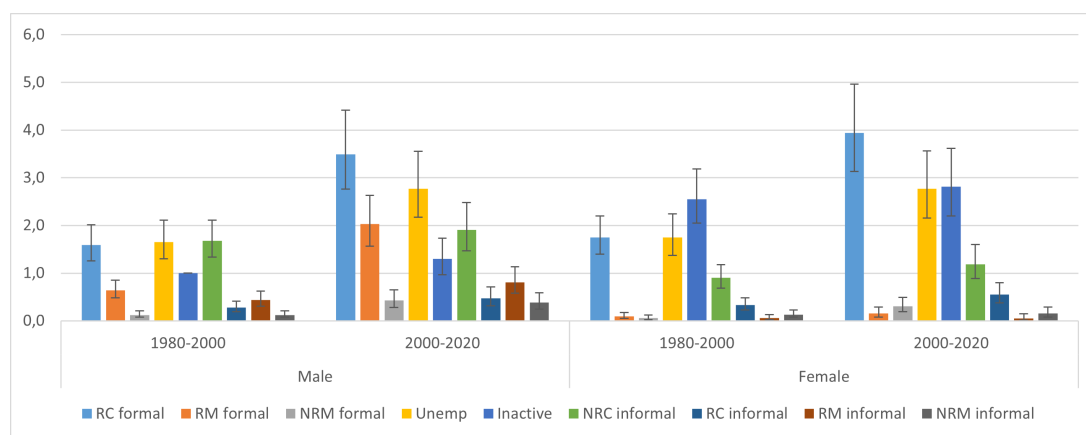
(c) By educational level

Source: Social Protection Survey of Chile, authors' own calculations.

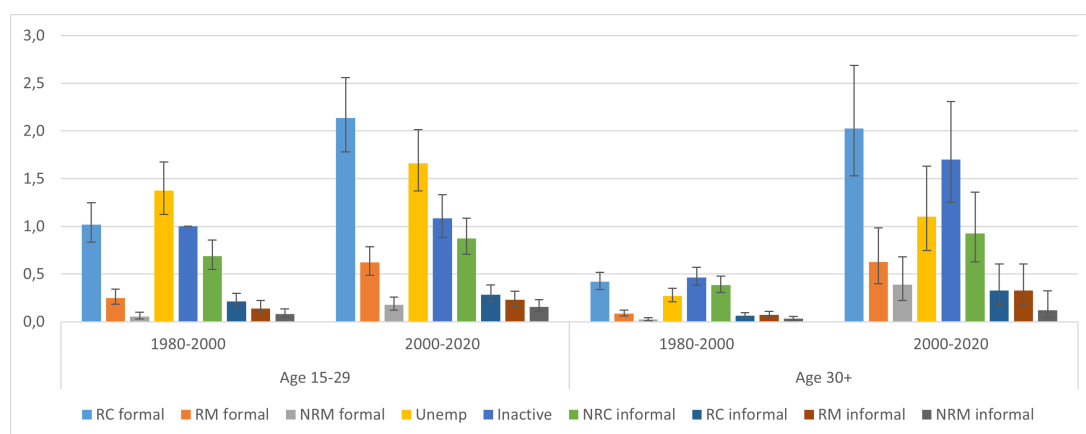
Notes: The figure presents the relative risks of a transition over time for NRM formal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.



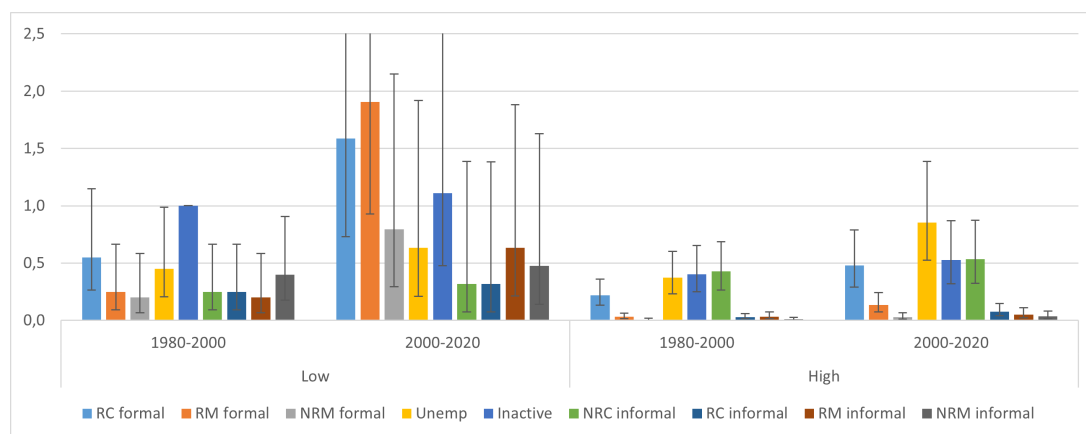
Figure B.10. Relative risks of a transition by type of transition over time for NRC formal workers



(a) By sex



(b) By age group

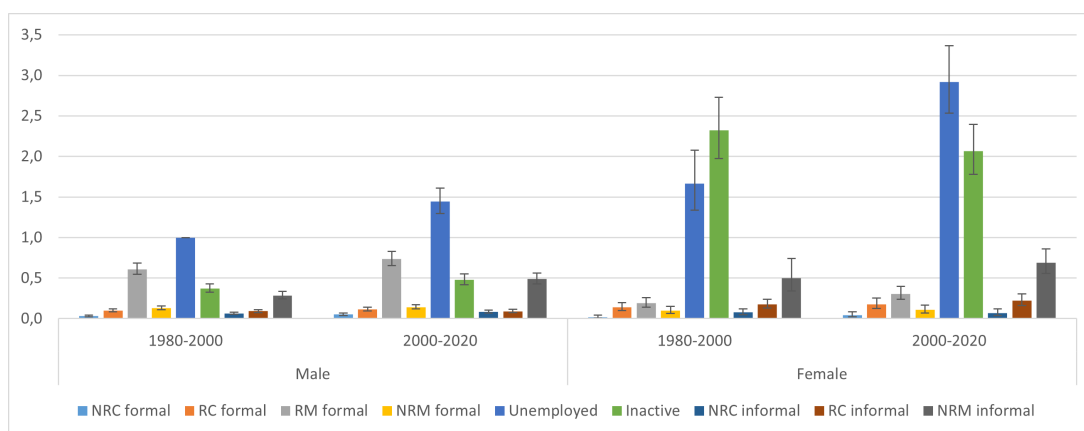


(c) By educational level

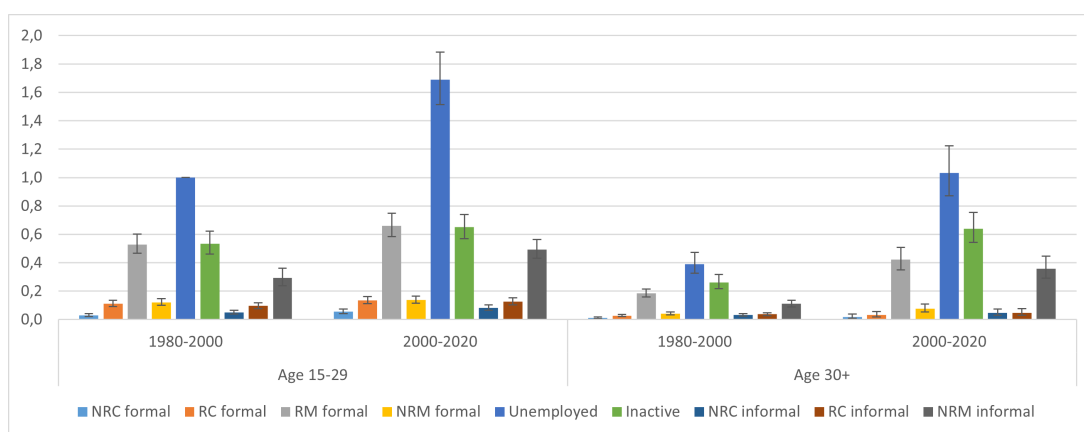
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for NRC formal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to inactivity in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

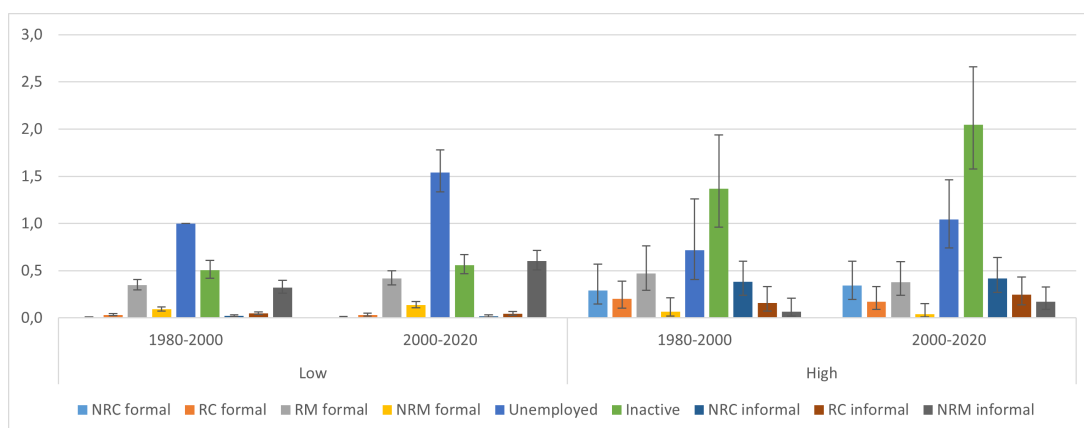
Figure B.11. Relative risks of a transition by type of transition over time for RM informal workers



(a) By sex



(b) By age group

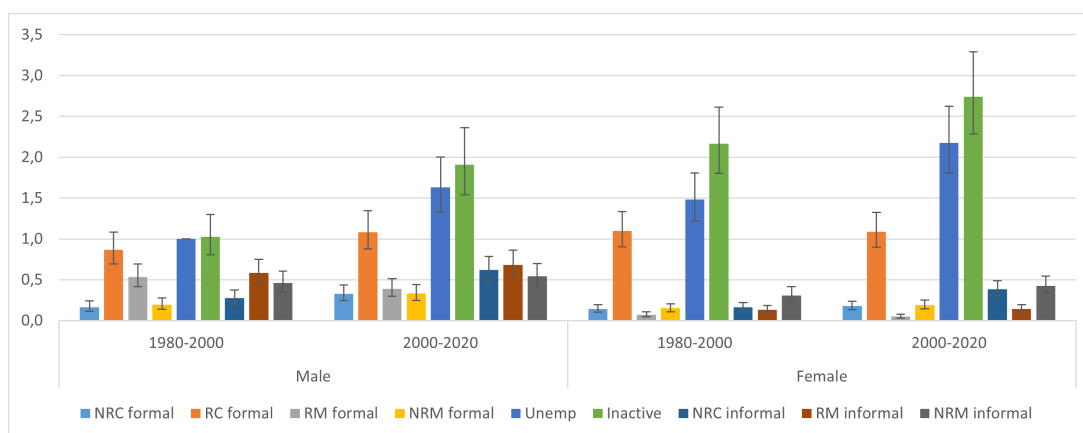


(c) By educational level

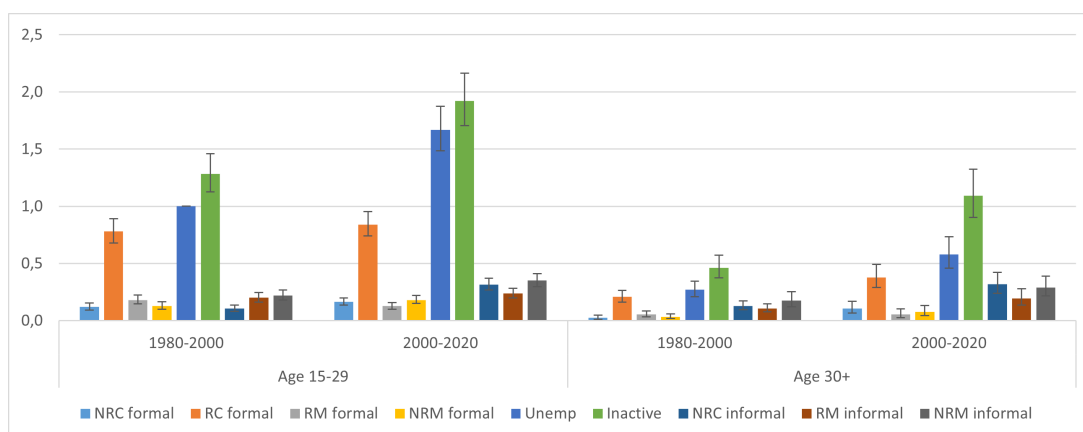
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for RM informal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to unemployment in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

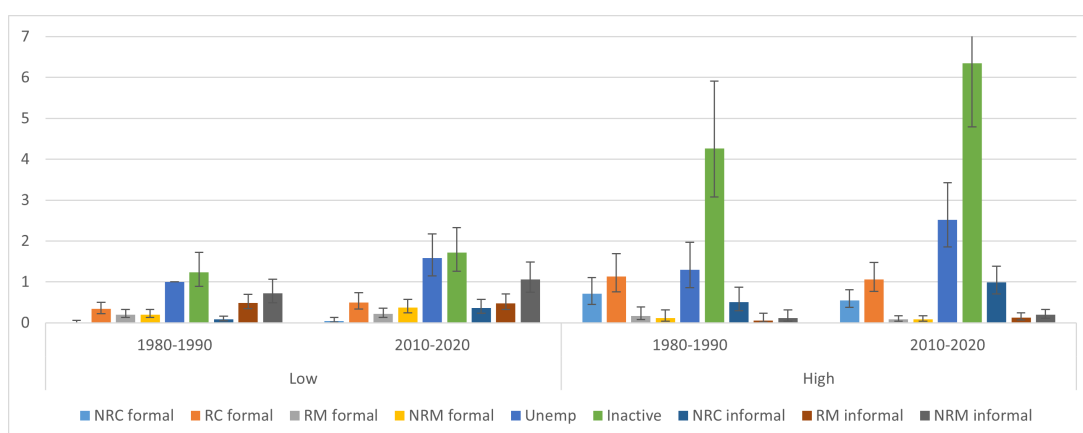
Figure B.12. Relative risks of a transition by type of transition over time for RC informal workers



(a) By sex



(b) By age group

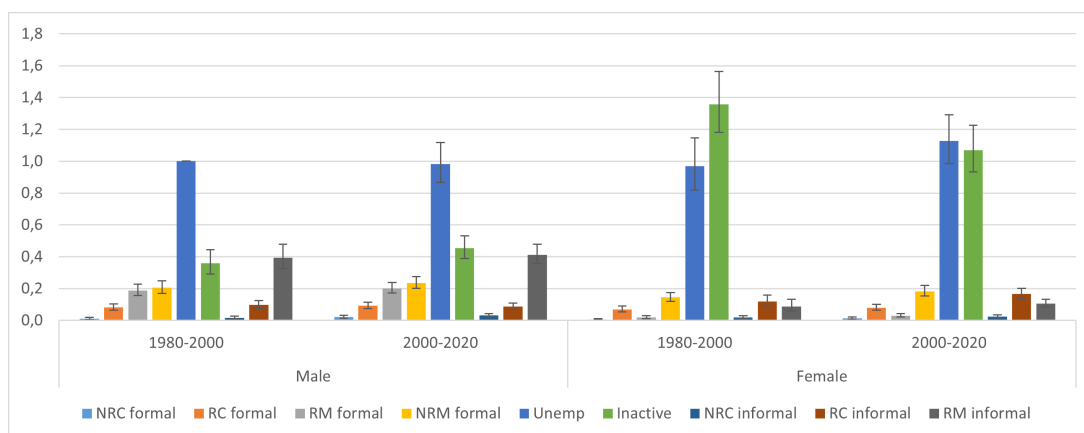


(c) By educational level

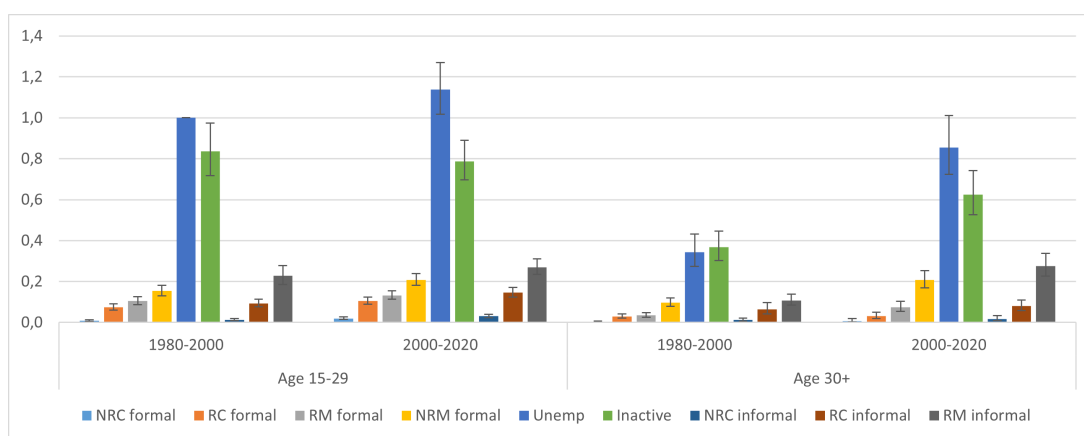
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for RC informal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to unemployment in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

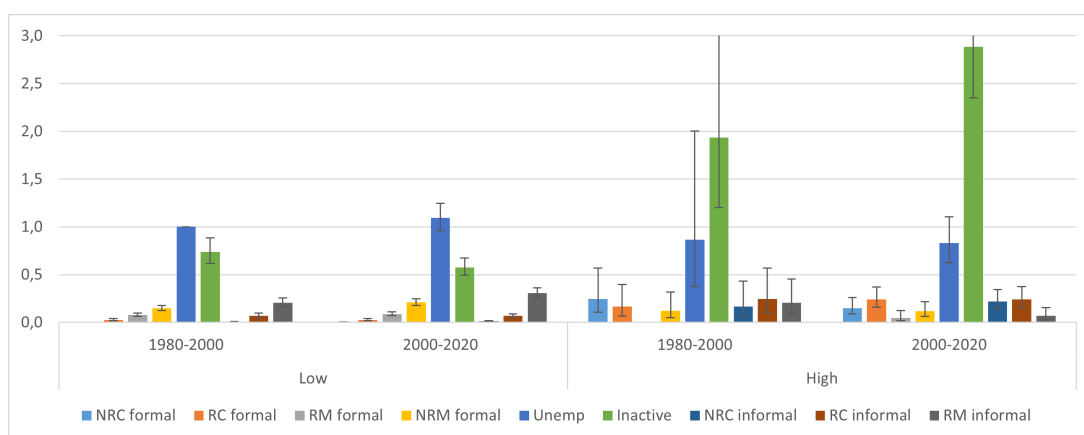
Figure B.13. Relative risks of a transition by type of transition over time for NRM informal workers



(a) By sex



(b) By age group

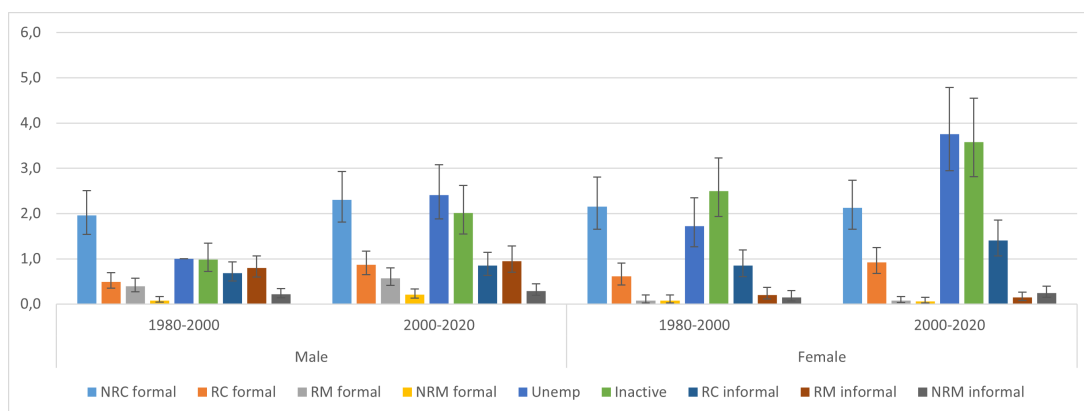


(c) By educational level

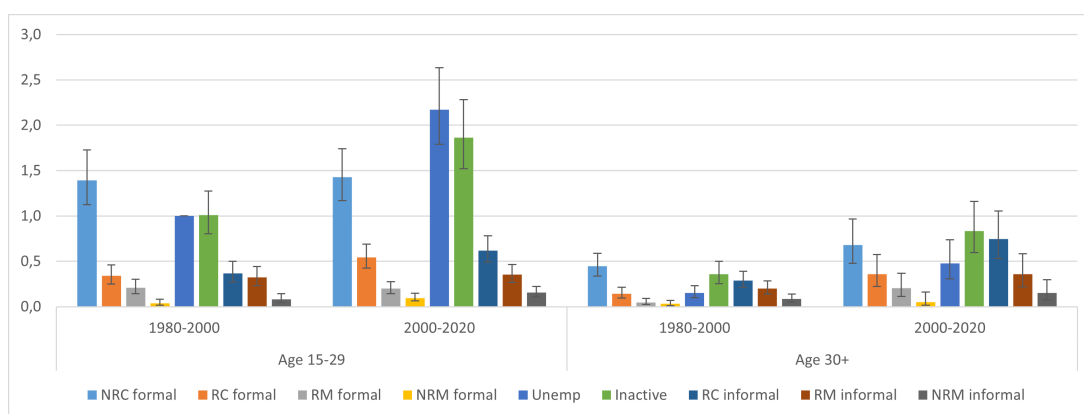
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for NRM informal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to unemployment in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

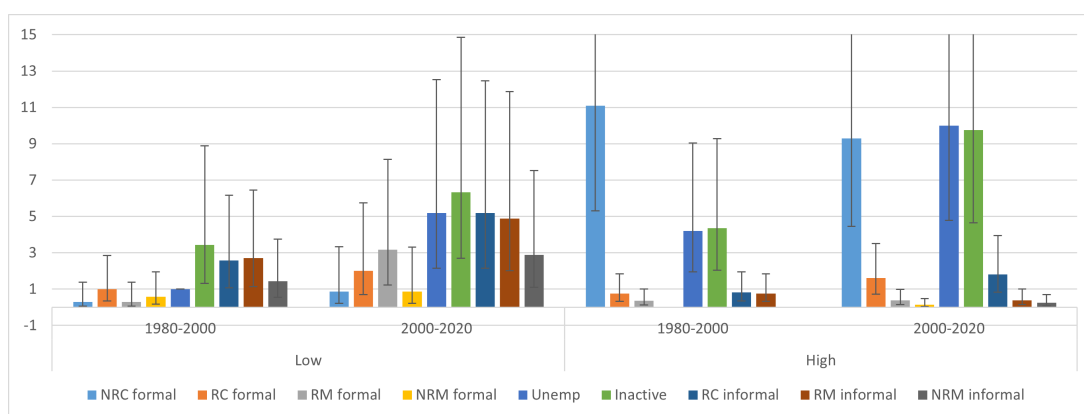
Figure B.14. Relative risks of a transition by type of transition over time for NRC informal workers



(a) By sex



(b) By age group

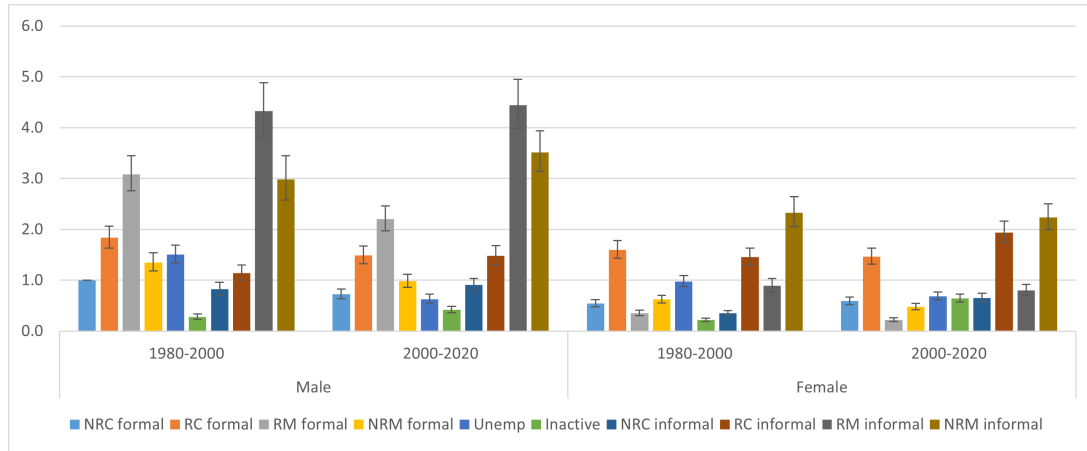


(c) By educational level

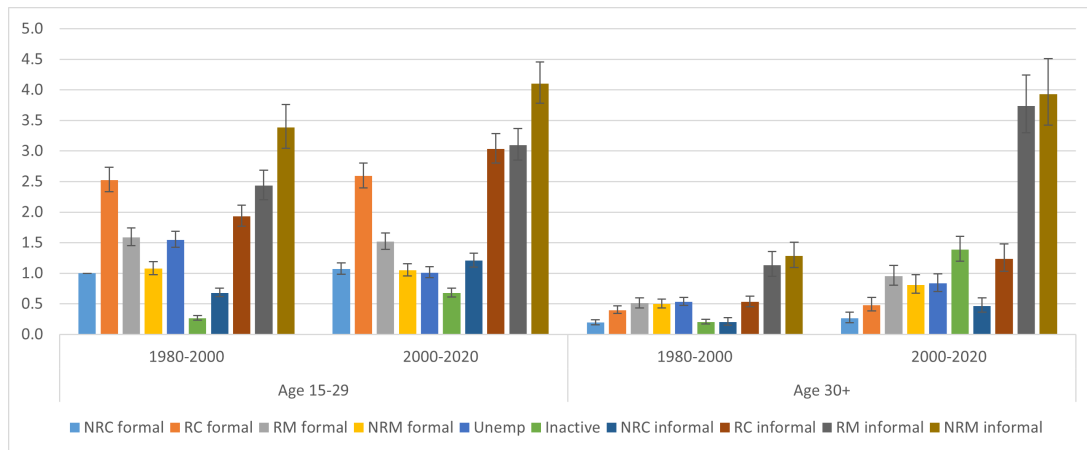
Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for NRC informal workers: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transiting to unemployment in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.

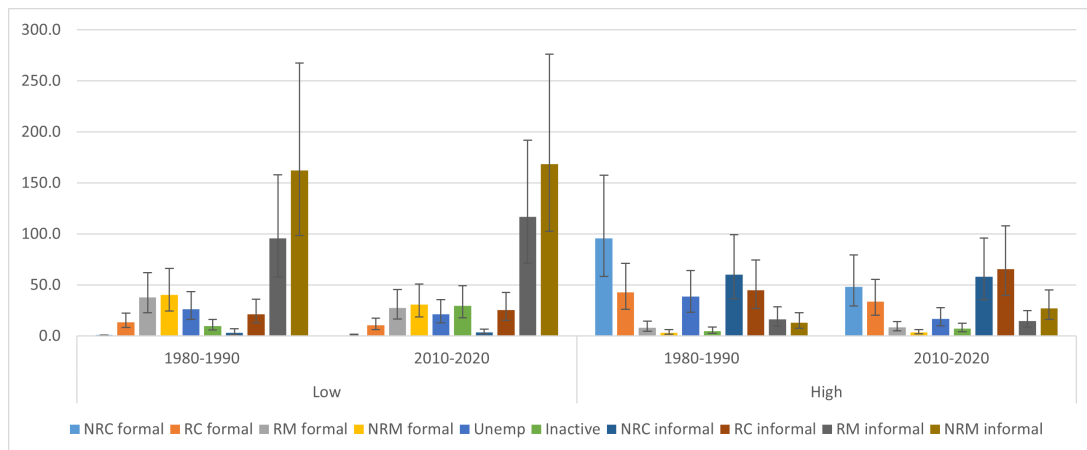
Figure B.15. Relative risks of a transition by type of transition over time for individuals who are out of employment



(a) By sex



(b) By age group



(c) By educational level

Source: Social Protection Survey of Chile, authors' own calculations.

Notes: The figure presents the relative risks of a transition over time for individuals who are out of employment: a) by type of transition and sex, b) by type of transition and age group, and c) by type of transition and educational level. All the models are adjusted when needed for sex, age, level of education, order of transition and time spent in the initial state. The reference category is transitioning to NRC formal occupations in the 1980s. 95% confidence intervals are also reported. Some categories may be missing and this means that their relative risk is null.