Labor Earnings Dynamics in a Developing Economy with a Large Informal Sector

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Abstract

We study labor earnings dynamics in a developing economy with a large informal sector. We use nationally representative Brazilian panel data that cover both formal and informal workers. We document large disparities in earnings fluctuations faced by these segments of the labor market, as well as the high frequency of transitions between them. Informality is associated with more volatile earnings, while workers in the formal sector are subject to significant downside risk. Transitions between formal and informal employment bring large asymmetric earnings shocks and have a frequency that depends on age and the initial earnings level.

JEL codes: E24, E26, J24, J31, O17

Keywords: Earnings dynamics, higher-order earnings risk, non-Gaussian shocks, informality

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1 Introduction

Uninsurable earnings risk influences many individual decisions and takes center stage in contemporary Macroeconomics. In the volatile economies of developing countries, it is reasonable to expect these risks to be large and impactful. While a good match with an expanding firm can translate into accelerated accumulation of experience and wage gains for a worker, a negative shock, such as a layoff from a company experiencing waning economic activity, can lead to a long-term loss of formal employment and a difficulty in ever recovering the same level of income.

Recent research with large panel datasets has documented a rich set of features for the empirical behavior of labor earnings risk.[1] Income risk is pervasive, but the availability of appropriate data has been constrained most learnings to a select group of developed economies. In this paper, we document key facts about labor earnings dynamics in a developing economy. We use Brazilian panel data from the first quarter of 2012 through the second quarter of 2018 that cover the whole country. As in countries with similar income levels, informality plays a large role in the labor market, and a failure to account for it leads to a biased market description.[2]

An informal worker is defined as someone whose employment record is not registered through the country's social security systems.[3] As such, there is no compliance with statutory labor rights and obligations. For example, there is no enforcement of the mandated employer contributions to social security, no layoff compensation, no access to unemployment insurance upon job separation, and, potentially, no paid time off. While on the one hand, conditions for informal workers are generally considered to be worse than in the formal sector, on the other hand, informal employment can offer an alternative which is especially valuable to some groups of workers, such as young people entering the job market or recently laid-off workers.

We first document the high transition rates between the formal and informal sectors. We also show how these transitions vary with worker characteristics. For instance, young workers originally employed in the informal sector are more likely to find a formal job compared to older workers. We then study several higher-order moments of the distribution to account for heterogeneity in labor earnings risk

[1] See, for example, Arellano, Blundell, and Bonhomme (2017), De Nardi, Fella, and Paz-Pardo (2019), and Guvenen, Karahan, Ozkan, and Song (2019).

[2] International Labor Organization (2013) compiled statistics on employment in the informal economy from 47 medium and low-income countries. In 15 countries, informal employment represents at least two thirds of total non-agricultural employment, and in 24 countries it exceeds 50 per cent.

[3] In particular, a formal worker in Brazil has a required registration in *Carteira de Trabalho e Previdência Social* (CTPS, a passport-like worker ID) and *Relação Anual de Informações Sociais* (RAIS), a required filing with the Labor Ministry.

across age groups, current income level, and status of employment, and to describe the likelihood of transitions between these. We find many striking differences between the nature of the earnings risk faced by workers under formal and informal labor arrangements.

Formal sector workers typically enjoy both higher levels of earnings and less volatile innovations. The standard deviation of log-earnings innovations[4] is 0.46 log-points for workers who are initially in the formal sector, while it is 0.73 for workers who are in the informal sector. However, the nature of the risks each set of workers faces is markedly different.

A transition from the formal to the informal sector is a significant negative shock: on average, a worker who switches to informality loses 0.28 log-points of net earnings from one year to the next. These innovations are reasonably heterogeneous (a conditional standard deviation of 0.70) and also significantly left-skewed (-0.74), emphasizing the role of further downside risk even within the group that suffers the negative shock. In the other direction, a switch from the informal sector to formal employment presents a somewhat mirror reflection of these shocks. A worker typically gains 0.18 log-points, with a distribution that has a conditional standard deviation of 0.67 and is positively skewed (0.51).

We also document that earnings innovations show large asymmetries and kurtosis and study how the distribution of these shocks depends on individual characteristics, such as the level of income and age. Our main finding is that transitions across sectors are very frequent (approximately 15% of workers change their employment form from one year to the next) and age dependent. Young workers are much more likely to transition between sectors. Also, it is typically the low-earning workers from the formal sector who fall into informality most easily, while high-earnings workers from the informal sector that most frequently switch to formal employment.

Finally, we extend the analysis to study unemployment and business cycle patterns. We find evidence that informal employment acts as a buffer against unemployment: transitions between unemployment and the informal sector are more likely than between unemployment and the formal sector. This is especially true during recessions. However, even though these transitions exhibit business cycle variation, conditional on the sector, the distributions of labor income innovations are quite acyclical.

This paper connects to four strands of the literature. First, there are studies documenting labor earnings risk in a variety of countries. Meghir and Pistaferri (2011) provide a survey of the literature studying the United States, the country with the absolute majority of articles. Other developed countries

[4]We study innovations in residuals of log-net-earnings, after deflating, imputing taxes and mandatory social security contributions due, and removing age and year effects. See Section 2 for details.

have also been studied, like the U.K. (Dickens, 2000), Canada (Baker and Solon, 2003), Italy (Cappellari, 2004), Spain (Alvarez, 2004), and Germany (Krebs and Yao, 2016). Given the context of these economies, these works do not focus on the differences between formal and informal sectors.

A second set of recent papers uses rich micro data sets to study nonlinear and higher-order aspects of labor earnings risk, such as Arellano et al. (2017), De Nardi et al. (2019), and Guvenen et al. (2019). We also document high-order risk, but add to this literature by focusing on the importance of both within-sector earnings risk and frequent risky sectoral transitions.

There are also papers that work with Brazilian data specifically, as we do here. Alvarez, Benguria, Engbom, and Moser (2018) study the recent decrease in labor earnings inequality among formal workers in Brazil. Engbom and Moser (2018) relates the rise of the minimum wage in Brazil to the decrease in income inequality. Menezes-Filho, Muendler, and Ramey (2008) documents changes in wage compensation in the country. Some papers also look at the relationship between the Brazilian trade liberalization episode and income inequality; e.g., Adão (2016) and Dix-Carneiro and Kovak (2015). We contribute to this literature by documenting differences in wage shocks experienced by both formal and informal workers.

Finally, there is also a literature that focuses directly on informality. Meghir, Narita, and Robin (2015) studies informal firms in Brazil. Ulyssea (2018) allows informal firms to coexist with formal firms that may hire informal workers. Both papers include workers who are not subject to income shocks. Other papers focus on the relationship between informality and trade (Coşar, Guner, and Tybout, 2016), tax collection and productivity (Ordóñez, 2014, De Paula and Scheinkman, 2010; 2011), job creation and destruction (Bosch and Esteban-Pretel, 2012), economic development (La Porta and Shleifer, 2008), and regulation (Rocha, Ulyssea, and Rachter, 2018). None of these papers focuses on differences in labor earnings risk across formal and informal sectors, as we do.

This paper is organized in four additional sections besides this introduction. Section 2 describes the data and the construction of the earnings measure. Section 3 discusses the empirical findings, and Section 4 reports additional analyses regarding unemployment and business cycle variation. Finally, Section 5 concludes.

2 Data and measurement

We use Brazilian survey data from the *Pesquisa Nacional por Amostra de Domicílios Contínua* (PNADC) ranging from the first quarter of 2012 through the second quarter of 2018. This survey is conducted by the *Instituto Brasileiro de Geografia e Estatística* (IBGE), which is the agency responsible for official collection of statistical information in Brazil. The PNADC aims to produce indicators that monitor quarterly fluctuations in the workforce. It has national coverage and takes both the formal and informal sectors into consideration.

In each quarter, the PNADC surveys around 211,000 households in approximately 16,000 census tracts. It follows a rotation scheme known as 1–2(5), where each household is visited five times during five consecutive quarters. The second visit occurs three months after the first one, the third visit happens three months after the second, and so on. This last feature allows us to construct a panel dataset that keeps track of individuals for an interval of one year.

2.1 Sample selection

Our final sample considers workers with ages between 18 and 65, focusing on an age range over which individuals have a strong labor market attachment. We keep only employed individuals with positive earnings in two consecutive years. To assess if a worker belongs to the formal or informal sector, we use their report of an employment record in their *Carteira de Trabalho e Previdência Social* (CTPS). This document is issued by the Brazilian Ministry of Labor and a new record is required for all formal employment relationships in the private sector. This CTPS record contains information on the characteristics of the job, such as compensation, and must be signed by both the employer and the employee. Additionally, our classification of formal workers includes employees in the public sector and armed forces. Complementarily, informal workers are employees without a CTPS record, those who are self-employed, and unregistered housekeeping workers. We exclude the small mass of employers from the analysis.[5]

Table 1 presents the number of observations in the pooled sample. The total number of workers with positive earnings for two consecutive years amounts to more than half million, of which around 60% are men. Figure 1 breaks down the sample over time and the form of employment. The row labeled F-F

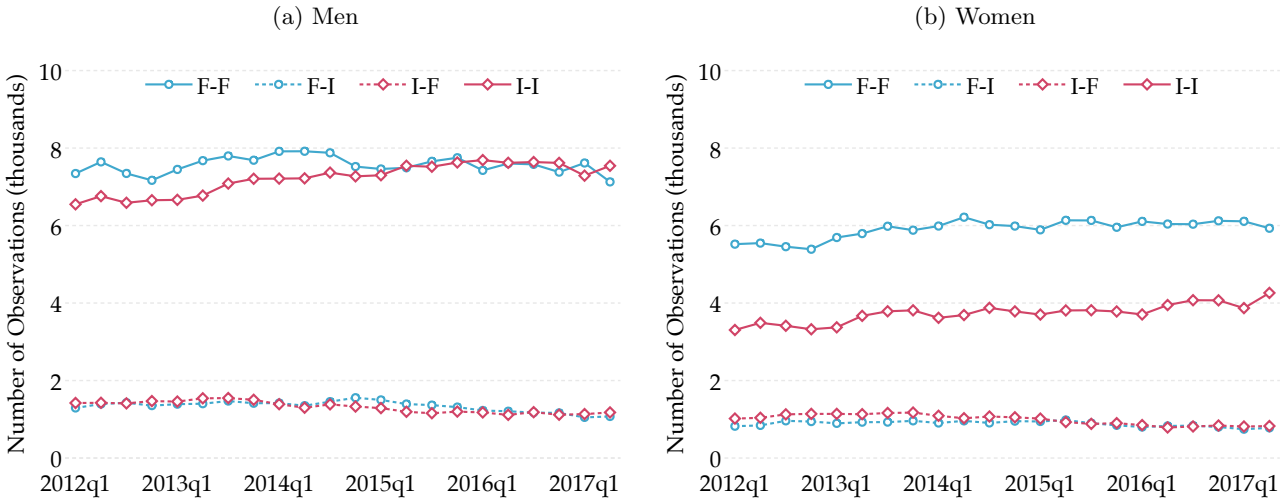
[5]Our classification for an informal worker follows previous papers; e.g., Engbom and Moser (2018) and Meghir et al. (2015). We also conducted two robustness analyses for different definitions of an informal worker: i) we classified college-educated self-employed workers as formal; and ii) we classified the self-employed workers who report contributing to social security as formal. The results, available upon request, are very similar to the benchmark analysis reported here.

Table 1: Sample description

	Men		Women		Total	
	N	%	*N*	%	*N*	%
F-F	166,415	43.4	129,921	51.3	296,336	46.5
F-I	29,384	7.7	19,443	7.7	48,827	7.7
I-F	28,906	7.5	21,820	8.6	50,726	8.0
I-I	158,719	41.4	82,170	32.4	240,889	37.8
Total	383,424	100	253,354	100	636,778	100

Notes: This table presents the number of occurrences for all possible combinations of forms of employment in the initial and terminal observations of an individual. F denotes formal employment, while I denotes informal employment.

Figure 1: Sample size over time



Notes: The values on the horizontal axis refer to the first quarter of a one-year period. For example, the values under "2016q1" refer to the number of workers present in both 2016q1 and 2017q1.

shows workers who had a job in the formal sector both in a given period and one year later. The row labeled F-I shows workers who had a formal job in a given period and an informal job one year later. The rows labeled I-I and I-F have symmetric interpretations.[6] Transitions across formal and informal employment are stable and non-trivial. These transitions are the main focus of the analysis in Section 3.2.

[6]Note that though we can observe the sector (formal or informal) in which a worker is employed, we do not have information regarding his/her employer. Therefore, we cannot identify job-to-job transitions.

2.2 Residual net earnings measure

We are interested in a measure of disposable income. Our starting point is the monthly gross income from the main job available in the data. We first subtract worker's contributions to Social Security. We apply the official rules of the *Instituto Nacional do Seguro Social* (INSS), which is the Brazilian Social Security Institute. We took into account that discount schedules vary by year and are not homogeneous across all workers. In Brazil, for instance, formal workers of the private and public sectors are subject to different Social Security regimes, and therefore face different marginal rates of contribution. Also, some informal workers in our sample report contributing to Social Security on their own. In such cases, we apply the official rules for the autonomous contributor category. Table 3 in Appendix A presents the details of the Social Security schedules used.

Next, we deduct income tax from the monthly earnings net of Social Security payments. We use the tax brackets of the *Secretaria da Receita Federal do Brasil* (RFB), which is the Brazilian Internal Revenue Service. The tax schedules also vary by year, but are homogeneous across all formal workers. On the other hand, we make no such deduction for informal workers, as they are not subject to income tax enforcement. Table 4 in Appendix A shows a breakdown of the income tax schedules adopted.

At this point, we have a monthly net income measure in nominal terms. Real earnings were calculated in 2018Q3 Reais (R$) using the Brazilian price index *Índice Nacional de Preços ao Consumidor Amplo* (IPCA). We used the monthly and regional indexes provided by IBGE, taking into account regional differences in the inflation rate. To get an annualized measure, we multiply the monthly real net income of formal and informal workers by 13.33 and 12, respectively. The unusual multiplier adopted for formal workers has its roots in the regulation of the Brazilian formal sector. By law, these workers are entitled to an additional thirteenth monthly salary every year plus one-third of a monthly salary as vacation allowance. Although deferred within the calendar year, both payments are computed in proportion to each monthly payment.[7]

Finally, we remove age and temporal effects from the annualized real net earnings measure. We do so by regressing the logarithm of such measures on dummies of age, quarter, and the interaction between them. Formally, let $y_{i,j,t}$ be the annualized real net earnings of worker i, with age j, in quarter t. Then, the specification estimated by OLS is given by

$$\ln y_{i,j,t} = \delta_j + \gamma_t + \delta_j \gamma_t + e_{i,j,t},$$

[7] More details are available in Law 13.467/2017.

where δ_j is the age dummy, γ_t is the quarter dummy, and $e_{i,j,t}$ is the error. We make no assumptions on the error's structure, to enable its non-parametric analysis. The estimate $\hat{e}_{i,j,t}$ is what we call the *residual net earnings measure*. Then, the one year change in the residual net earnings is defined as

$$\Delta\hat{e}_{i,j,t} \equiv \hat{e}_{i,j+1,t+4} - \hat{e}_{i,j,t}.$$

This kind of measurement is standard in the literature and can be found, for instance, in Guvenen, Ozkan, and Song (2014) and Guvenen et al. (2019).

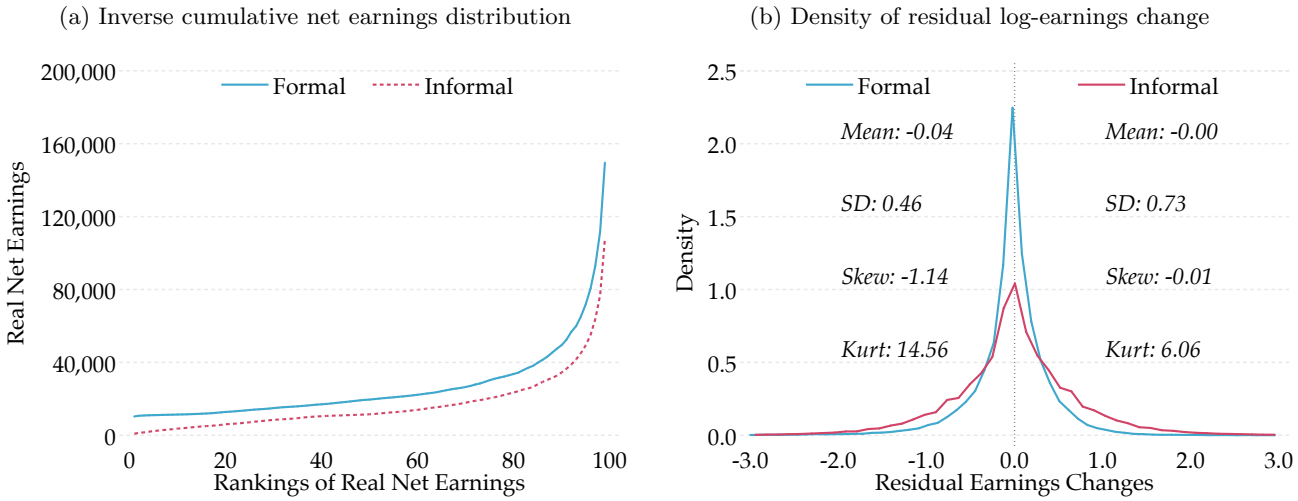
From now on, we restrict the analysis to the sample of male workers. This is done for comparability to earlier work (e.g. Guvenen et al. (2019)) and because men usually transition less into and out of the labor force. However, when we restrict attention to women participating in the labor force, results are similar. Also, the main findings are largely unchanged when studying gross income.[8]

3 The earnings dynamics of formal and informal workers

We first study the distribution of the level of earnings across the two segments of the labor market. As Figure 2a illustrates with the inverse cumulative distribution, workers under a formal employment arrangement fare significantly better. Their conditional distribution of earnings dominates, in a first-order stochastic sense, the earnings distribution of informal workers. This difference is expected given previous studies of the Brazilian labor market.[9] Much less, however, is known about the risky evolution of individual labor earnings in developing economies. What are the key features of the growth trends and embedded risk in the earnings of workers? How do transitions across sectors affect their earnings perspectives? Which workers are especially subject to these transitions?

[8] The results for female workers and for gross income are available upon request.
[9] See, for example, Botelho and Ponczek (2011).

Figure 2: The behavior of net earnings, conditional of form of employment



Notes: The panel on the left displays the inverse cumulative distribution of net earnings: on the horizontal axis we have shares between 0 and 100%, while the curves display the respective quantiles of the distribution of earnings (conditional on the sector of employment). The panel on the right displays the densities of the earnings distributions for the two sectors of employment and moments associated with these distributions.

Figure 2b plots the probability density of log-earnings changes, conditional on the sector of participation at date t. A few features are noteworthy. First, workers in the formal sector are subject to significant downside risk in their income processes, as evidenced by a the negative skewness (-1.14). This downside risk is largely explained by the presence of transitions out of formal employment, which we document further in the following sections. Income drops upon a transition to informal employment also help explain the negative mean change (-0.04 log-points) in earnings for workers who are originally formally employed.

At the same time, the earnings of workers originally in the informal sector are more volatile, as indicated by the standard deviation of 0.73, compared with a lower 0.46 for workers originally in the formal sector. Unlike the risk for formal sector workers, the risk faced by informal laborers is symmetric (its skewness is roughly zero). There is also a noticeable difference in kurtosis (14.56 for formal sector workers, 6.06 for informal sector workers, both exceeding the normal distribution), which is the subject of further study in the following sections. In these sections, to dig deeper into the nature of income risk faced by individuals in the two labor market segments, we separate sector "stayers" and workers experiencing a sector transition.

3.1 Sector stayers

We now focus on "stayers", workers who are observed in the same sector of employment over one-year-apart surveys. Notice that formal sector stayers are the single group typically covered by high-quality administrative data.[10] One of our main objectives is to document how a labor income dynamics description based solely on data covering the formal sector would miss important features of the earnings risk faced by workers in a developing economy.

Figure 3 explores the shape of the density functions for sector stayers. We can observe large deviations from normal distributions with the same mean and variance, with a typical case of high kurtosis: a central spike, thin shoulders around this spike, and heavy tails. This feature is especially pronounced for formal sector stayers, whose kurtosis for log-earnings changes is 19.37.[11] Informal sector stayers, in their turn, are associated with a kurtosis of 5.87. Although shadowed by the behavior of the formal sector's counterpart, this is still significantly higher than the kurtosis displayed by the normal distribution. Both distributions are slightly left skewed (skewness of -0.65 and -0.08, respectively), emphasizing the importance of a thick tail of negative shocks. Guvenen et al. (2019) and De Nardi et al. (2019) also find large deviations from normality in the U.S. labor market, with the former using administrative Social Security data and the latter using the Panel Study of Income Dynamics (PSID).

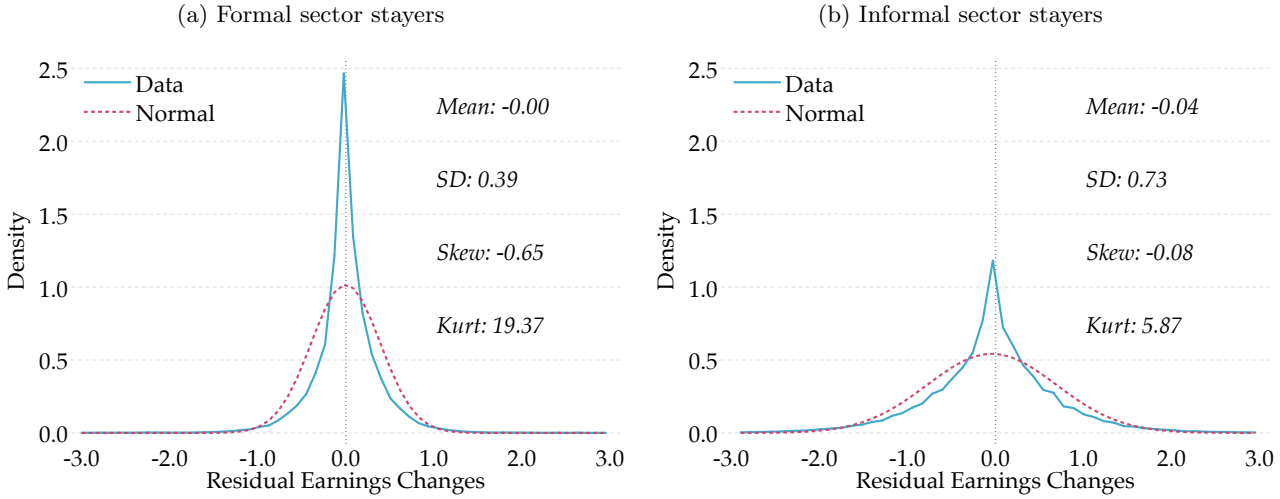
Studying Panel 3a, notice that the mean earning change of formal sector stayers is essentially zero. This contrasts with the -0.04 we documented in Figure 2.2b, which focused on all workers who were initially in the formal sector. Also, the skewness is now -0.65 log-points, lower than the original -1.14. These two features indicate that the negative mean and high negative skewness are attributable to transitions out of formal employment. In an analogous fashion, when we compare Panel 3b and the results from the previous section, we can conclude that a large degree of the upside risk faced by informal sector workers is attributable to the possibility of finding a formal job. When we restrict attention to informal sector stayers (in contrast to all workers who were originally informally employed) the mean earning change is -0.04 (as opposed to zero) and displays some negative skewness (-0.08, as opposed to -0.01).

While one can already perceive that current employment status shapes the income risk faced in the Brazilian labor market in important ways, a large degree of heterogeneity remains unexplored by the current analysis. For instance, are younger workers more likely to suffer sector transitions that will

[10] In the particular case of Brazil, the RAIS database from the Ministry of Labor.
[11] The value of the kurtosis of a normal variable is 3.

ultimately determine their long-term prospects? Are better paid workers more likely to suffer large negative drops in earnings? How transient is informality and how largely is it a phenomenon experienced by low-pay workers? To answer questions like these and further separate risk from heterogeneity, we study, in the next two subsections, transitions and the behavior of earning changes conditional on current sector, earnings level, and age.

Figure 3: Earnings innovations, stayers



Notes: The panel on the left displays the density of earnings innovations for formal sector stayers (workers that are observed in the same sector in two observations separated by one year). The panel on the right replicates this illustration for informal sector stayers. For a comparison of shapes, both panels also display a normal distribution density with the same mean and variance.

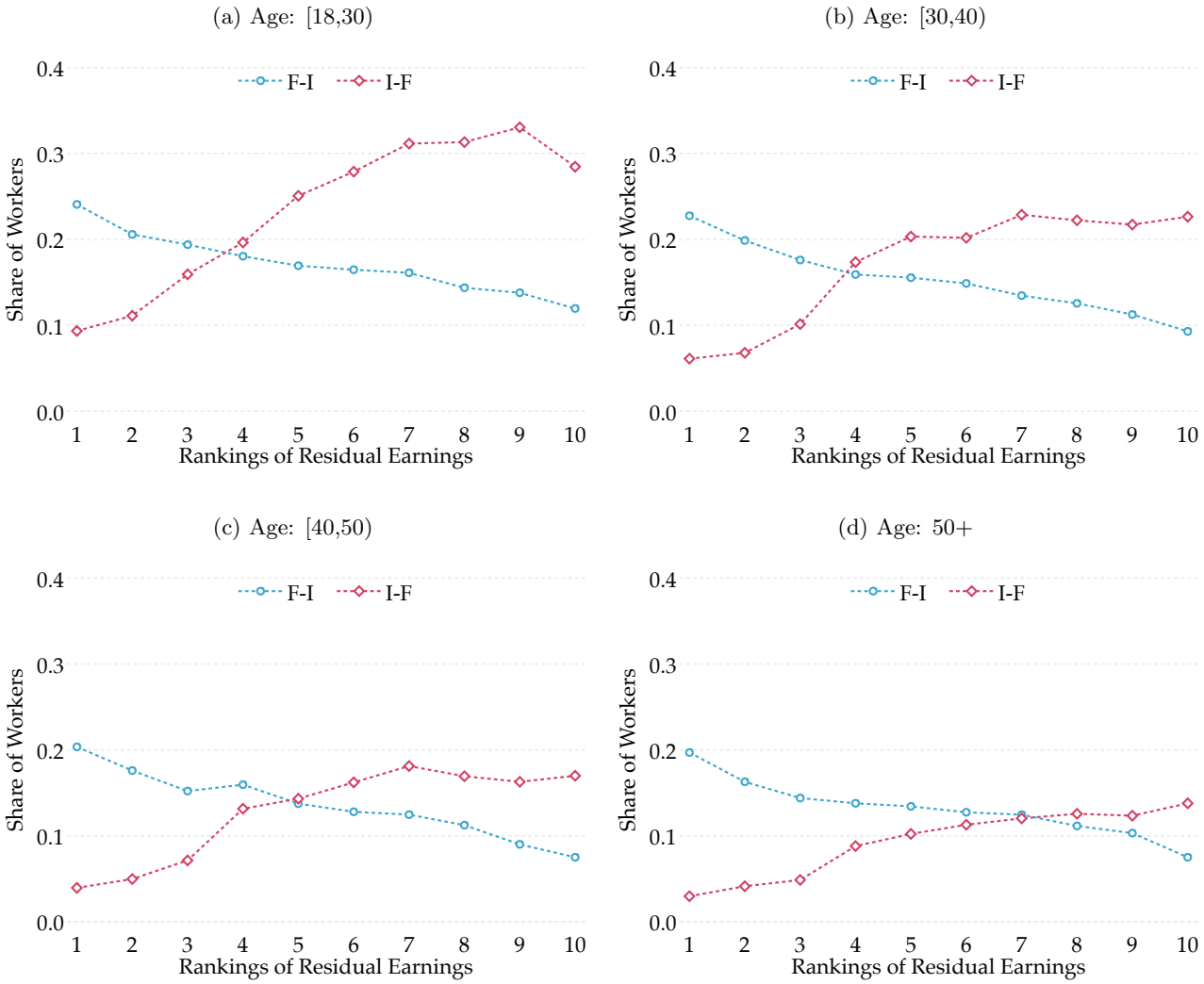
3.2 Transitions between sectors

As seen in Figure 2, large discrepancies between formal and informal sector workers' earnings are observed in the data. Worker characteristics might play an important role. Also, while the previous section focused on individuals who stay in the same sector across years, it is important to understand how much income risk is associated with transitions in employment status. In this section, we tackle both of these issues: first, how does sector transition risk behave as a function of age and earnings quantile? And second, what is the typical behavior of earning changes for workers who transition between the two sectors?

Figure 4 plots the yearly intensity of labor market sector transitions as a function of age (which varies across panels a through d) and deciles of the conditional earnings distributions (which vary along the horizontal axis). First, across all ages, better-paid formal workers are slightly more likely to remain in

the formal sector than worse-paid workers, but the variation is quantitatively small. Second, better-paid informal workers are always relatively more likely to transition to formal employment than lower-paid workers. Third, transitions out of informality are quite frequent for younger workers (especially higher income, around or slightly above 30% over a year), but tend to fade out for older workers.

Figure 4: Transition frequencies

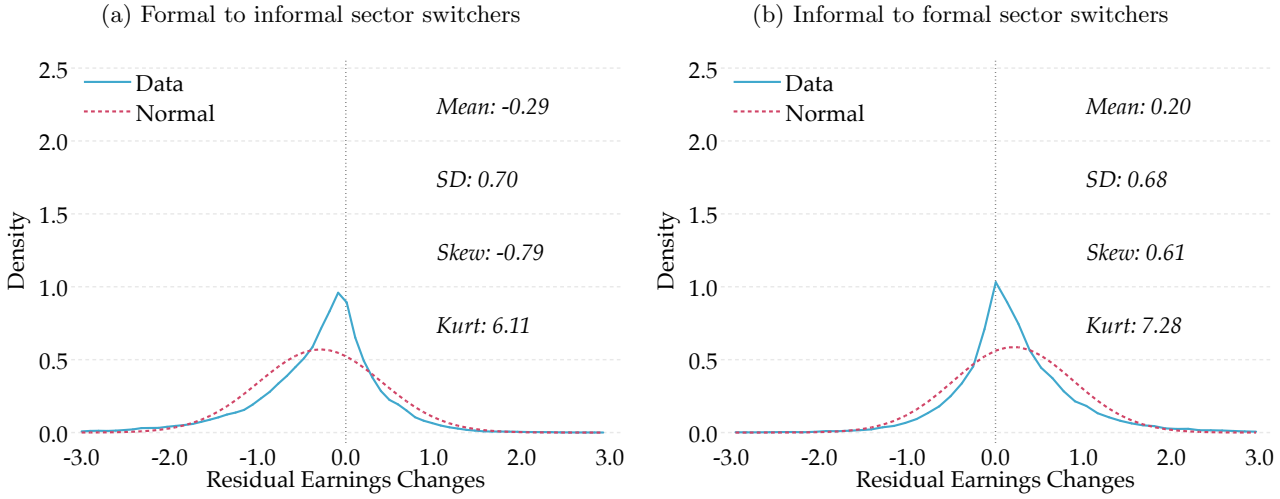


Notes: The four panels display average sector transition frequencies for workers in different age groups. I denotes informal employment, while F denotes formal employment. F-I denotes an agent transitioning from formal at t to informal employment at $t+1$, while I-F denotes a transition in the opposite direction.

Figure 5 studies the shape of log-earnings innovations for workers who are subject to a sectoral transition. In both of these figures, we aggregate over age to make the presentation clear. Workers transitioning toward the informal sector have, on average, a very large earning loss of -0.29 log-points. This distribution is also left skewed, with a skewness statistic of -0.79. A fairly opposite picture emerges

for workers making the inverse transition: a mean earning gain of 0.20 log-points and a right-skewness of 0.61. Despite this almost inverted-image behavior in terms of average and skewness of earnings innovations, workers experiencing transitions face similar standard deviations of innovations (0.70 for workers transitioning into informality and 0.68 for workers transitioning away from it) and relatively high kurtosis (6.11 and 7.28, respectively).

Figure 5: Earnings innovations, transitions



Notes: The panel on the left displays the density of the earnings innovations for workers who are observed in formal employment at t, while in informal employment at $t+1$. The panel on the right displays the density of innovations for workers who experienced the transition in the opposite direction. For a comparison of shapes, both panels also display a normal distribution density with the same mean and variance.

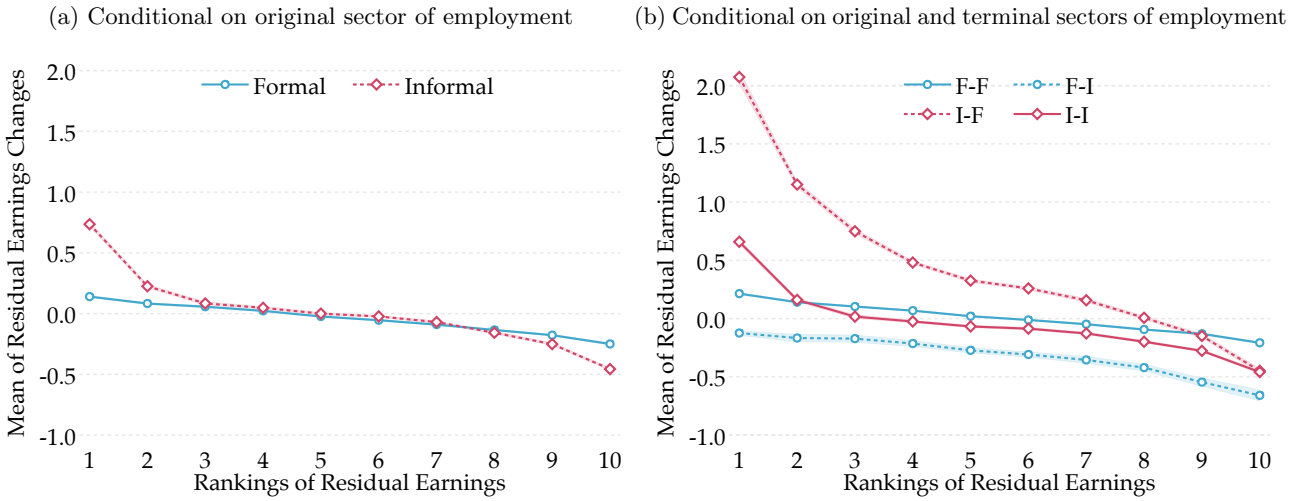
3.3 More on key moments

For a deeper understanding of earnings risk and the consequences from heterogeneity, we disaggregate the four central moments not only by employment sector, but also by age and income groups following Guvenen et al. (2019). A first lesson from this exercise is that age has little quantitative impact on the patterns displayed for conditional means, standard deviation, skewness, and kurtosis. This does not imply that age is not an important determinant of labor earnings risk, as we have documented that it has consequences through the probability of transitions across the two forms of employment. We take advantage of the modest impact of age on conditional moments and present simple plots in the main text, which disaggregate only by sectors and their conditional earning quantiles. Appendix B presents figures with data conditional on age.

Figure 6 plots mean log-earnings changes against earnings deciles (conditional on the original sector

of employment).[12] Notice that all curves in both panels are downward sloping, indicating a mean reversion in earnings. On the left-hand panel, we notice that this mean reversion is stronger for workers originally in informal employment arrangements, as indicated by a steeper slope of the curve for the informal sector, which is also stronger at extreme the quantiles. The right-hand panel decomposes mean earning changes for sectoral stayers and workers who were subject to sector transitions. A few additional features emerge. First, for all deciles, workers moving from formal employment into an informal arrangement one year later are subject to negative mean earning shocks. This aligns with the view that this form of transition is essentially a negative shock. On the other hand, workers making transitions from informal employment to a formal arrangement are typically subject to large earning gains, especially among lower-income individuals.[13] The behavior of the average earning change for sector stayers is not markedly different from what we see in Panel 6a.

Figure 6: Mean



Note: The shaded areas represent two-standard-error confidence bands, computed by bootstrap.

Figure 7 plots the standard deviation of log-earnings growth by conditional earnings decile. On Panel 7a, we see two important patterns emerge. First, there is more volatility around both extremes of the earnings distribution than around the median level. This U-shaped pattern is present in both sectors and survives further disaggregation. By inspecting Panel 7b, we also notice that the terminal sector is the major determinant of realized labor earnings volatility (as measured by squared residuals).

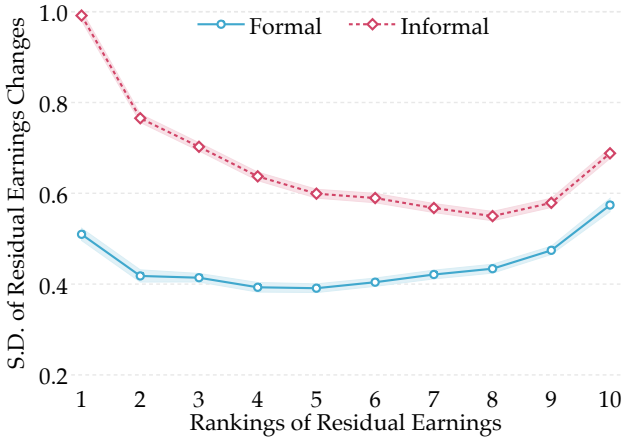
[12] The shaded regions in Figures 6-9 represent plus/minus two-standard-errors calculated from a bootstrapping procedure.

[13] Notice that we see an income loss at the highest quantiles. This might be a compensation for additional benefits of formal sector employment, such as pension contributions and improved job stability.

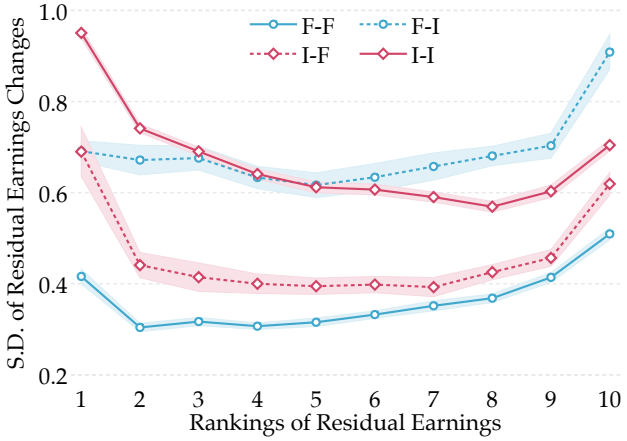
Individuals that move from the formal to the informal sector are typically the ones subject to the largest (typically negative) income innovations, while informal sector stayers are also subject to fairly risky earnings innovations. Formal sector stayers have the least volatile earnings. Overall, values between 0.4 and 0.9 for one-year variations of log-income are close in magnitude to those found in Guvenen et al. (2019) using tax-return data for the U.S. labor market.

Figure 7: Standard Deviation

(a) Conditional on original sector of employment



(b) Conditional on original and terminal sectors of employment

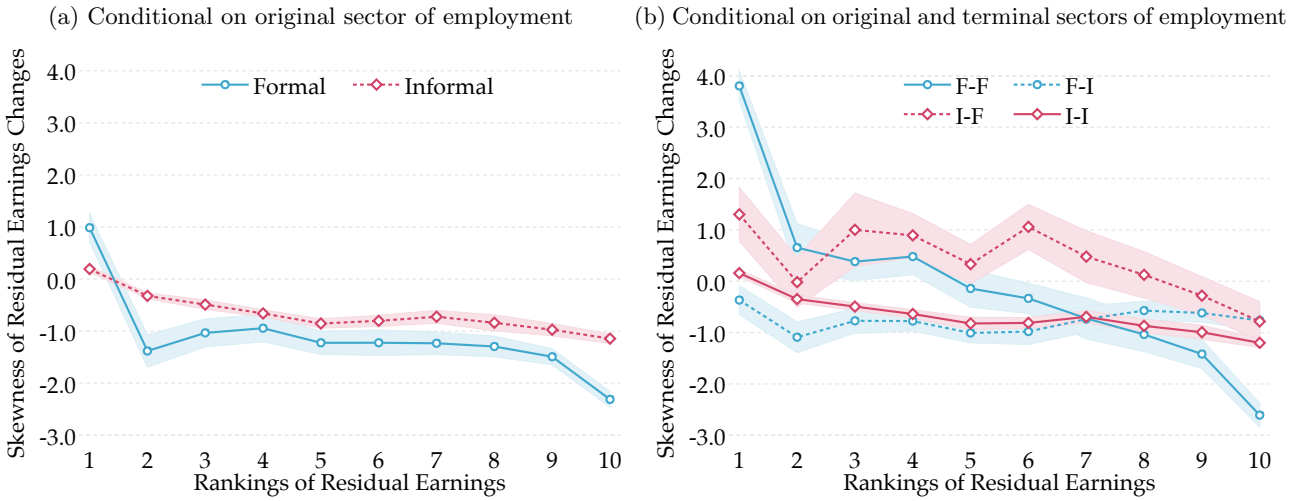


Note: The shaded areas represent two-standard-error confidence bands, computed by bootstrap.

In Figure 8, we display the conditional skewness of earnings changes. On Panel 8a, we see a typical left skewness, which is present in other contexts, such as U.S. earnings data, and is stronger for higher deciles of the earnings distribution. On Panel 8b, some nuances emerge. We can see a relevant positive skewness for workers transitioning from informality to formal employment, as well as in the lower deciles of the distribution of formal sector stayers. The former emphasizes the importance of formalization shocks, which are not only typically positive on average, but are also asymmetric. Positive skewness does not find any counterpart in the U.S. data, as studied in Guvenen et al. (2019).

Last, Figure 9 plots the conditional kurtosis of log-earning changes. Similar to age effects, conditional earnings deciles do not play a large role in the determination of kurtosis, while the sectors of the labor market matter greatly. Formal sector workers display a high conditional kurtosis (14.56 when aggregated over ages and income deciles, and 19.37 when further conditioned on stayers), which is particularly extreme for low-earnings workers. These values are comparable to what was found for U.S. workers (Guvenen et al., 2019). Although higher than the normal distribution, earnings changes for other sectoral

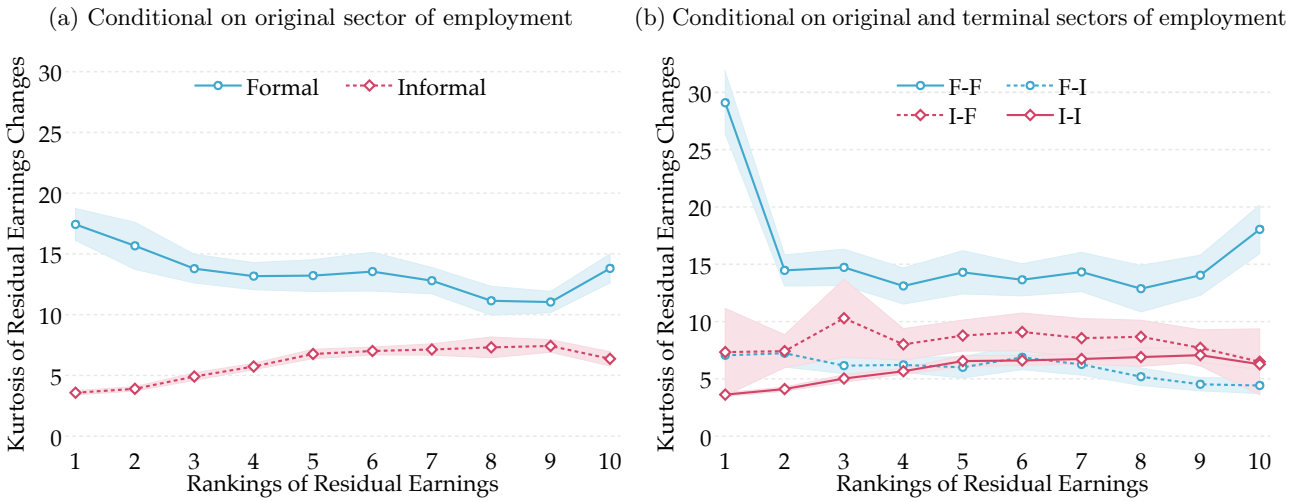
Figure 8: Skewness



Note: The shaded areas represent two-standard-error confidence bands, computed by bootstrap.

transitions display more moderate kurtosis values.

Figure 9: Kurtosis



Note: The shaded areas represent two-standard-error confidence bands, computed by bootstrap.

4 Additional analysis: Unemployment and the business cycle

In this section, we first study transitions in and out of unemployment. We show that transitions toward unemployment are not extremely frequent and discuss the insurance role that informal employment

plays. One limitation of the data is that, given its rotating-panel nature with individuals leaving the sample at the end of every year, it is impossible to trace clear patterns regarding unemployment spell duration and persistent income effects (scarring), for instance.

Then we turn our attention to the business cycle behavior of income shocks. Our data covers both quarters of economic expansions and recessions. This allows us to try to uncover any cyclical patterns in income innovation and to evaluate their decomposition into transition intensities and the behavior of income innovations, conditional on the initial and terminal states of employment.

Table 2 displays the total number of observations across all combinations of initial and terminal employment statuses when we consider three categories: formal employment, informal employment, and unemployment. Our sample includes roughly the same number of workers reporting formal and informal employment at a given date t (47.93% of the sample in the formal sector and 46.16% in the informal sector). Transitions to unemployment one year later (at $t+1$) are comparable, but slightly more frequent for workers who were initially informally employed (5.37%) than those initially under a formal employment arrangement (4.89%).

Out of the pool of initially-unemployed workers (25,364 observations or 5.91% of the sample), we see more frequent transitions to an informal work arrangement one year later (9,867 observations or 38.9% of those initially seen unemployed) than to a formal employment arrangement (7,728 observations or 30.47% of the unemployed workers). There is also a sizable share of unemployed workers that report still being unemployed when resurveyed one year later (7,769 observations or 30.63% of those initially unemployed).

Overall, these numbers are consistent with the interpretation that informality offers insurance and a buffer from unemployment. Formal workers are about three times more likely to report informal employment one year later (14.27%) than unemployment (4.89%). The high frequency of transitions from unemployment to informal employment are also consistent with that view.

Notice that these results average out across times of economic expansion and contraction. We now turn to what the data reveals in terms of business cycle patterns.

Our data contains quarters of economic expansion, as well as quarters that were classified as belonging to a recession by *Comitê de Datação de Ciclos Econômicos* (CODACE),[14] a business cycle dating committee similar to the one organized by the U.S.'s National Bureau of Economic Research (NBER). CODACE reported an economic contraction from 2014Q2 to 2016Q4. To study the business cycle

[14]For more information, see https://portalibre.fgv.br/price-indexes-and-surveys/codace/.

Table 2: Unemployment, Formal, and Informal Employment

	Flows								
	F-F	F-I	F-U	I-F	I-I	I-U	U-F	U-I	U-U
N	166,415	29,384	10,067	28,906	158,719	10,657	7,728	9,867	7,769
%	38.7	6.8	2.3	6.7	37.0	2.5	1.8	2.3	1.8

Notes: This table presents the number of occurrences of unemployment and all possible combinations of forms of employment in the initial and terminal observations of an individual. F denotes formal employment, I denotes informal employment, and U denotes unemployment. This is based on data for male workers only.

behavior of income shocks, we proceed as follows.

First, as before, we decompose the income shocks into transition intensities from each of the employment states and the conditional distribution of innovations for each combination of original and terminal states.[15] Further, we allocate observations into four different groups depending on the business cycle dates identified by CODACE. If an individual is surveyed in a quarter labeled as an economic expansion both initially and then again one year later, he is labeled E-E. If the terminal interview occurs in a recession quarter, he is labeled E-R, and so on for all four combinations.

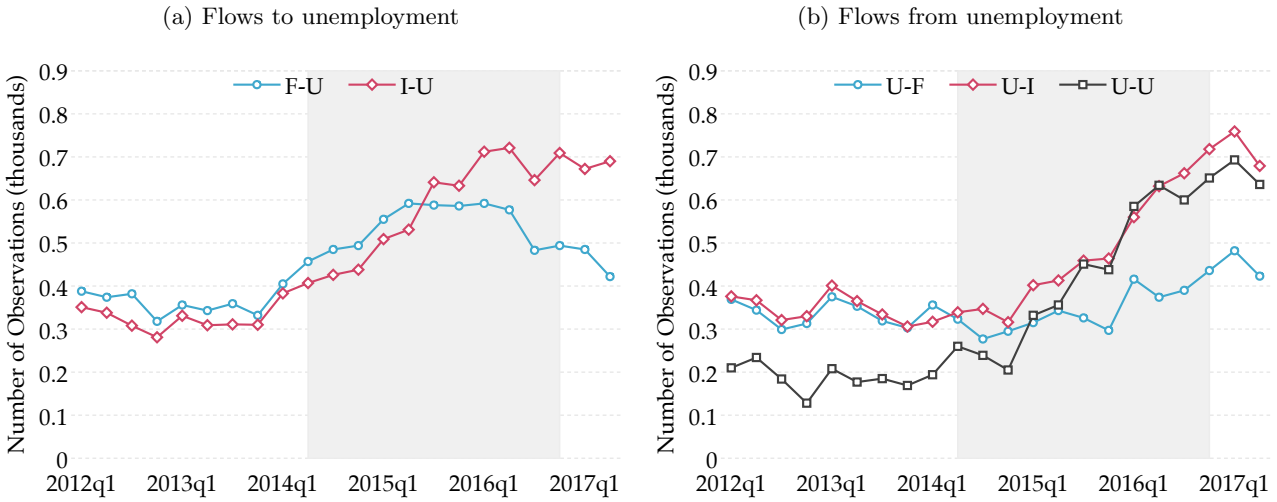
There is evidence of cyclicality in the transitions across states of employment. Figure 10 illustrates the flows in and out of unemployment from each of the two employment sectors. In Panel 10a, we see an increase in flows toward unemployment, which is consistent with the increase in unemployment during the recession. In particular, it is longer lasting and more pronounced for workers under informal employment arrangements.

In Panel 10b, we see that as economic conditions deteriorate after the second quarter of 2014, unemployment becomes more persistent. Also, despite the steady increase in the number of unemployed people, the flow out of unemployment toward formal employment remains roughly stable. An increasing flow out of unemployment only surfaces when considering transitions to informality. This is again consistent with the view that informality serves as insurance, and especially so in bad economic times.

In Appendix C, we restrict attention to workers who are employed, either in the formal or informal sector. Figure 16 shows that informality becomes more persistent during recessions. Figures 17 and 18 show that that conditional distributions of earnings innovations are essentially acyclical. This offers a good *a posteriori* justification for the decomposition of earnings shocks in transition intensities and

[15]Instead of focusing on two sectors, in the analysis in this section, we consider three states: formal employment, informal employment, and unemployment. In Appendix C, we follow the previous approach and disregard unemployed workers.

Figure 10: Transitions and the business cycle: Unemployment



conditional innovations.

5 Conclusion

We document the empirical patterns of labor earnings risk for a large developing economy, that of Brazil, devoting special attention to informal workers. Transitions between formal and informal employment are frequent, and are especially so for younger workers. A large part of labor earnings risk is realized upon these transitions: for instance, a transition toward informality leads to earnings innovations that are negative on average and negatively skewed. On the other hand, a transition toward formal employment leads to positive average gains and a positively skewed innovation distribution.

We extend the analysis to consider unemployment and study business cycle patterns. Results are suggestive of an insurance role for informal employment. First, transitions in or out of informal employment are much more frequent than those into and out of unemployment. Second, as unemployment increases during the recession that occurs during the sample timeframe, transitions into unemployment rise steadily and transitions from unemployment into informal employment become more frequent.

The different processes we characterize for formal and informal workers may have interesting implications for individual's consumption, savings, occupational choice, and other decisions. Their acknowledgement may also impact the design of public policies such as social security. We leave these issues for future research.

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Appendix

A Social security and income tax schedules

This appendix provides the income tax and social security schedules that we use for creating the net earnings measure, following the procedure described in Section 2.2.

Table 3: Social Security contribution schedules

	Private employee		Autonomous contributor	
Year	Wage base (R$)	Rate (%)	Wage base (R$)	Rate (%)
2018	up to 1,693.72	8.0	954.00	5.0
	1,693.73 to 2,822.90	9.0	954.00	11.0
	2,822.91 to 5,645.80	11.0	954.00 to 5,645.80	20.0
2017	up to 1,659.38	8.0	937.00	5.0
	1,659.39 to 2,765.66	9.0	937.00	11.0
	2,765.67 to 5,531.31	11.0	937.00 to 5,531.31	20.0
2016	up to 1,556.94	8.0	880.00	5.0
	1,556.95 to 2,594.92	9.0	880.00	11.0
	2,594.93 to 5,189.82	11.0	880.00 to 5,189.82	20.0
2015	up to 1,399.12	8.0	788.00	5.0
	1,399.13 to 2,331.88	9.0	788.00	11.0
	2,331.89 to 4,663.75	11.0	788.00 to 4,663.75	20.0
2014	up to 1,317.07	8.0	724.00	5.0
	1,317.08 to 2,195.12	9.0	724.00	11.0
	2,195.13 to 4,390.24	11.0	724.00 to 4,390.24	20.0
2013	up to 1,247.70	8.0	678.00	5.0
	1,247.71 to 2,079.50	9.0	678.00	11.0
	2,079.51 to 4,159.00	11.0	678.00 to 4,159.00	20.0
2012	up to 1,174.86	8.0	622.00	5.0
	1,174.87 to 1,958.10	9.0	622.00	11.0
	1,958.11 to 3,916.20	11.0	622.00 to 3,916.20	20.0

Notes: For public employees and armed forces, the contribution rate is fixed at twenty percent. The five percent rate for autonomous contributors holds for those classified as "Individual Microentrepreneur" or "Optional Low Income." The eleven percent rate for autonomous contributors holds for those included in the "Simplified Pension Plan". The source of the information presented in this table is the official website of INSS: https://www.inss.gov.br/servicos-do-inss/calculo-da-guia-da-previdencia-social-gps/tabela-de-contribuicao-mensal/tabela-de-contribuicao-historico/.

Table 4: Income tax schedules

Year	Wage base (R$)	Rate (%)	Deduction (R$)
2015: Apr+	up to 1,903.98	0.0	0.00
	1,903.99 to 2,826.65	7.5	142.80
	2,826.66 to 3,751.05	15.0	354.80
	3,751.06 to 4,664.68	22.5	636.13
	above 4,664.68	27.5	869.36
2015: Jan-Mar	up to 1,787.77	0.0	0.00
	1,787.78 to 2,679.29	7.5	134.08
	2,679.30 to 3,572.43	15.0	335.03
	3,572.44 to 4,463.81	22.5	602.96
	above 4,463.81	27.5	826.15
2014	up to 1,787.77	0.0	0.00
	1,787.78 to 2,679.29	7.5	134.08
	2,679.30 to 3,572.43	15.0	335.03
	3,572.44 to 4,463.81	22.5	602.96
	above 4,463.81	27.5	826.15
2013	up to 1,710.78	0.0	0.00
	1,710.79 to 2,563.91	7.5	128.31
	2,563.92 to 3,418.59	15.0	320.60
	3,418.60 to 4,271.59	22.5	577.00
	above 4,271.59	27.5	790.58
2012	up to 1,637.11	0.0	0.00
	1,637.12 to 2,453.50	7.5	122.78
	2,453.51 to 3,271.38	15.0	306.80
	3,271.39 to 4,087.65	22.5	552.15
	above 4,087.65	27.5	756.53

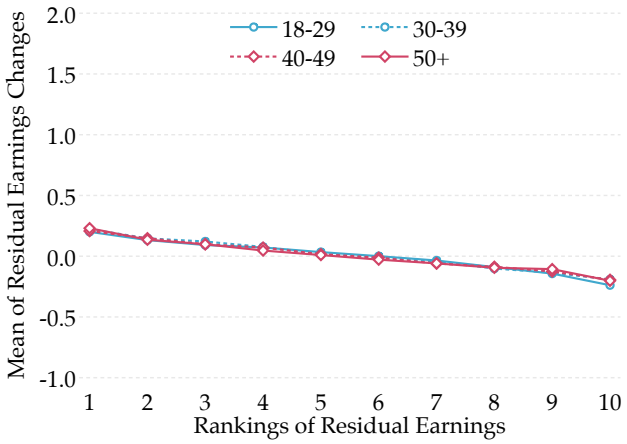
Notes: The source of the information presented in this table is the official website of RFB: http://idg.receita.fazenda.gov.br/acesso-rapido/tributos/irpf-imposto-de-renda-pessoa-fisica#tabelas-de-incid-ncia-mensal.

B The relative unimportance of age

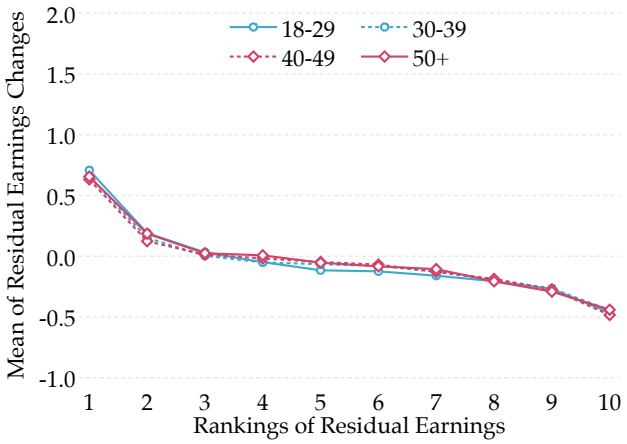
In this appendix, we further detail the four central moments of earnings innovations through conditioning at different age groups. A surprising pattern we identify is the relative homogeneity of these moments across the four age groups we study: 18-29, 30-39, 40-49, and greater than 50 years old. Only the standard deviation shows a noticeable age-dependent pattern, with risk increasing along with age.

Figure 11: Mean

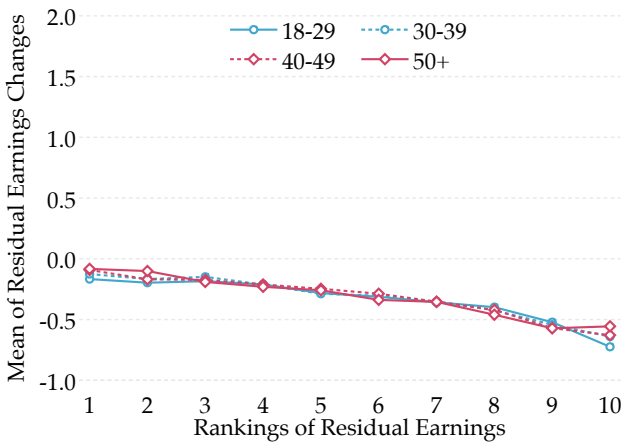
(a) Formal sector stayers



(b) Informal sector stayers



(c) Formal to informal transition



(d) Informal to formal transition

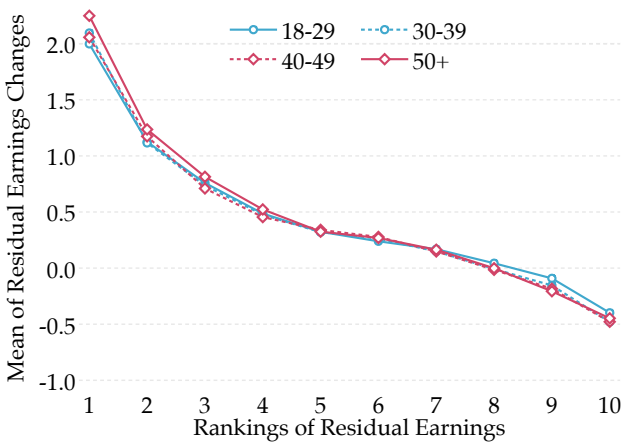
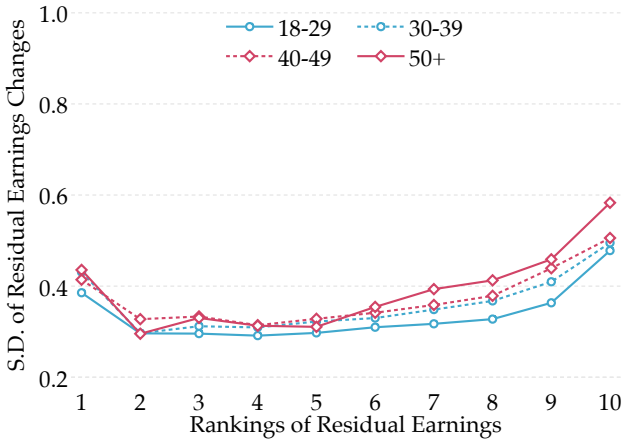
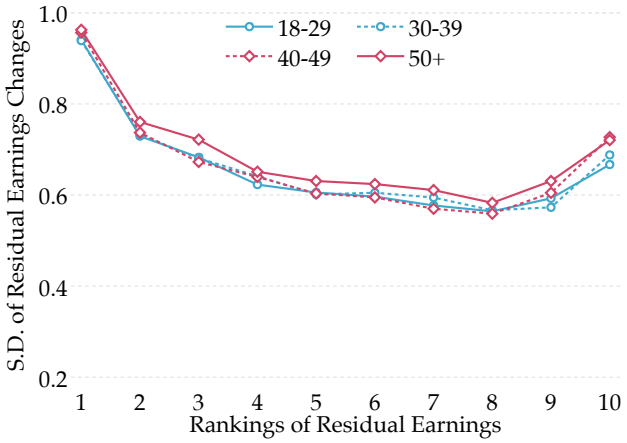


Figure 12: Standard deviation

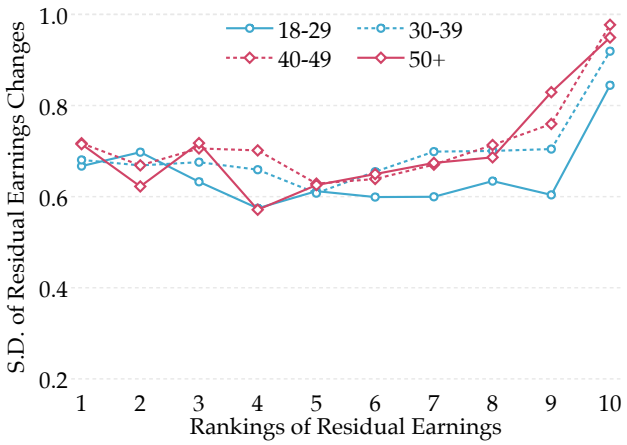
(a) Formal sector stayers



(b) Informal sector stayers



(c) Formal to informal transition



(d) Informal to formal transition

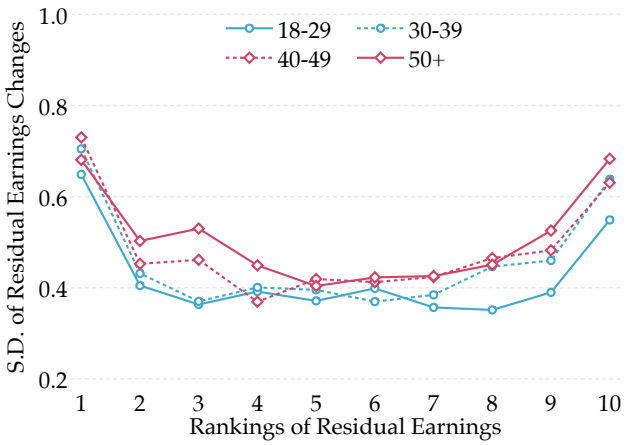
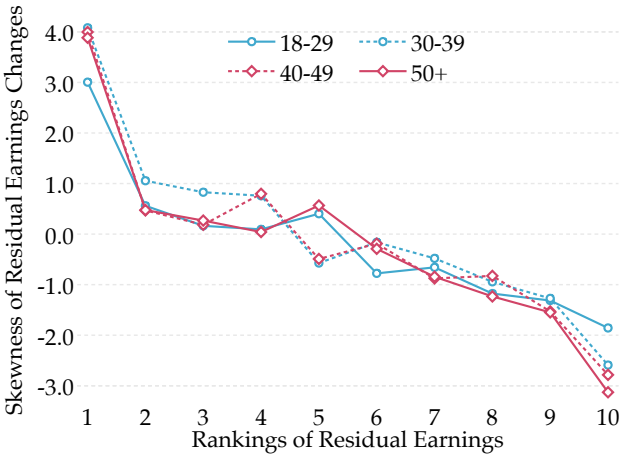
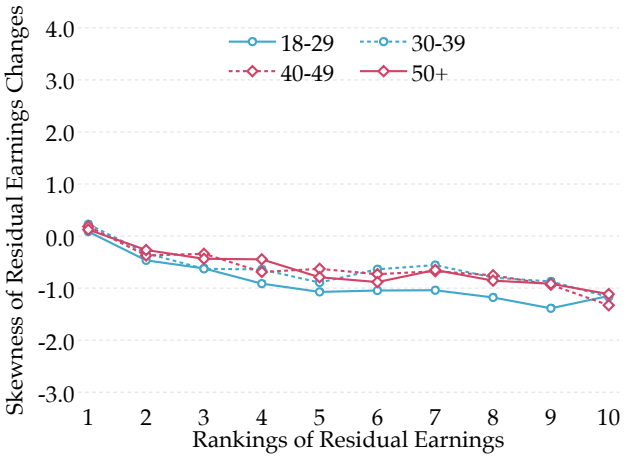


Figure 13: Skewness

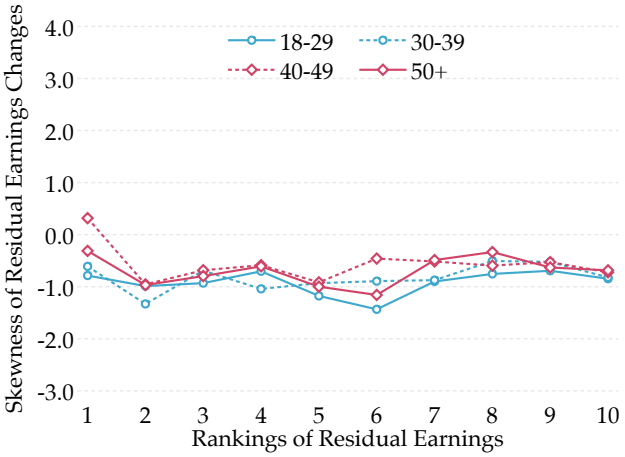
(a) Formal sector stayers



(b) Informal sector stayers



(c) Formal to informal transition



(d) Informal to formal transition

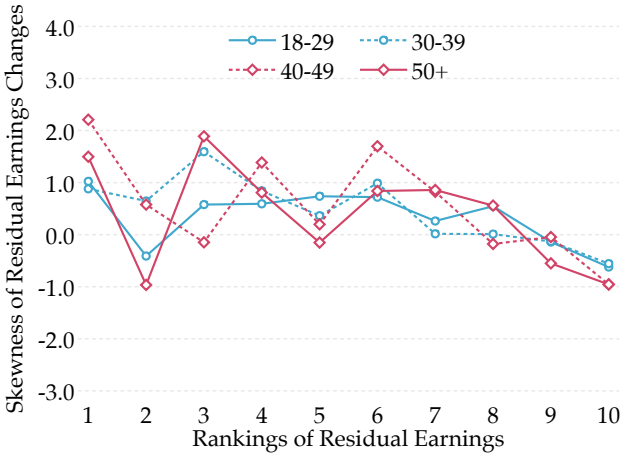
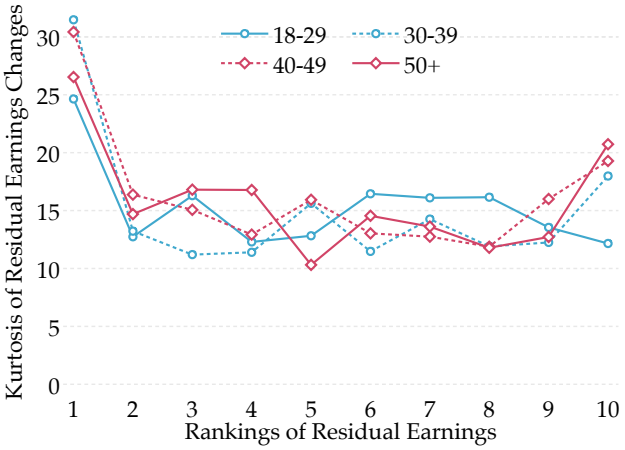
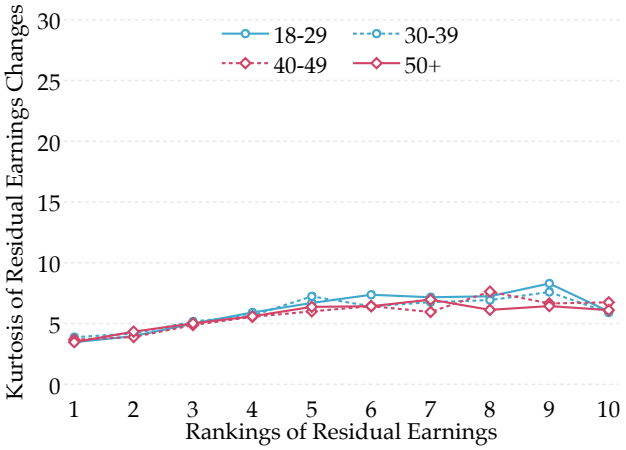


Figure 14: Kurtosis

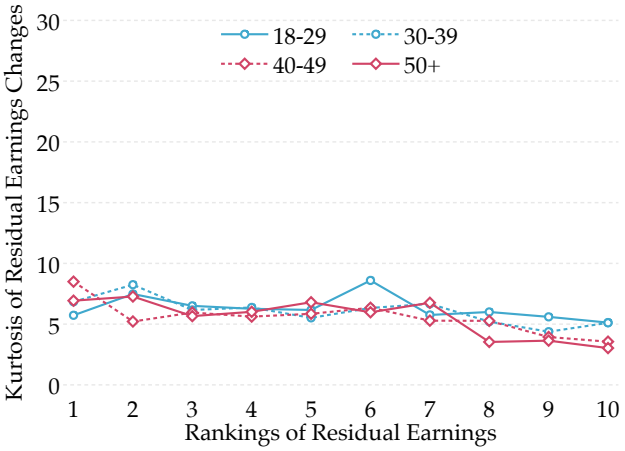
(a) Formal sector stayers



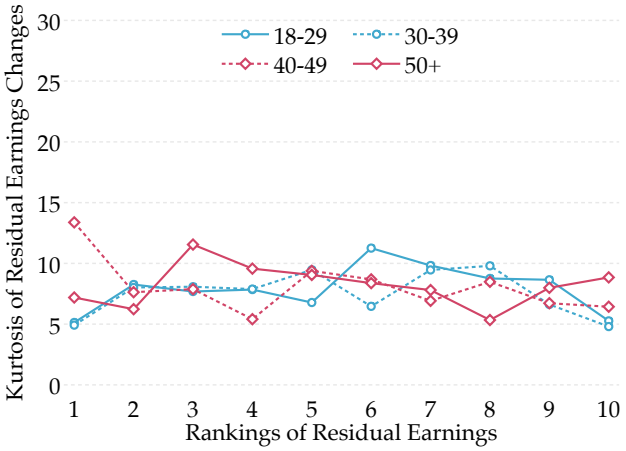
(b) Informal sector stayers



(c) Formal to informal transition



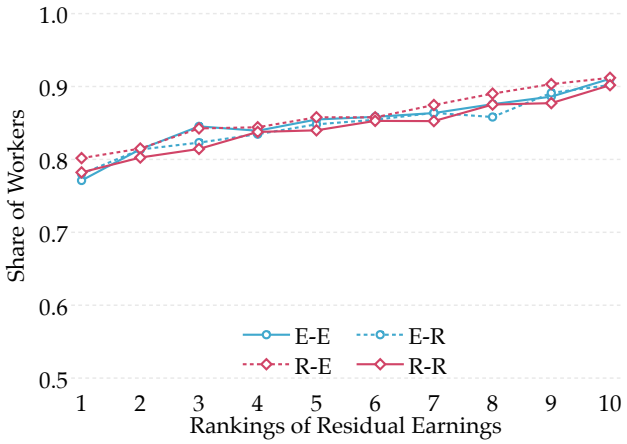
(d) Informal to formal transition



C Transitions and the stability of the earnings innovation distributions across the expansion and recession

Figure 15: Transitions and the business cycle: Formal sector workers

(a) Formal sector stayers



(b) Formal to informal sector switchers

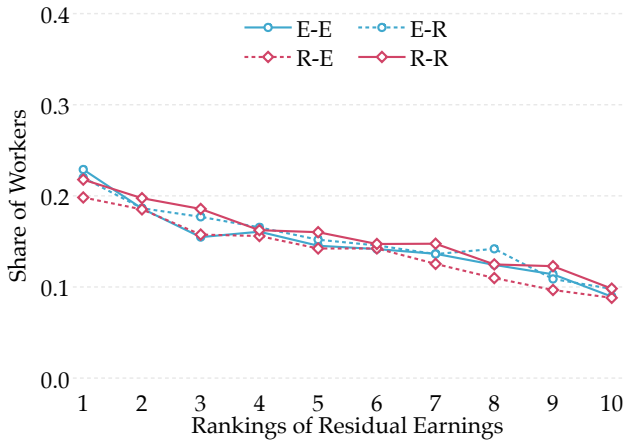
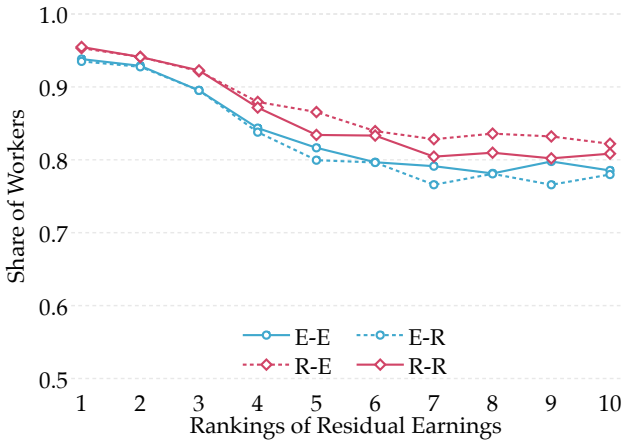


Figure 16: Transitions and the business cycle: Informal sector workers

(a) Informal sector stayers



(b) Informal to formal sector switchers

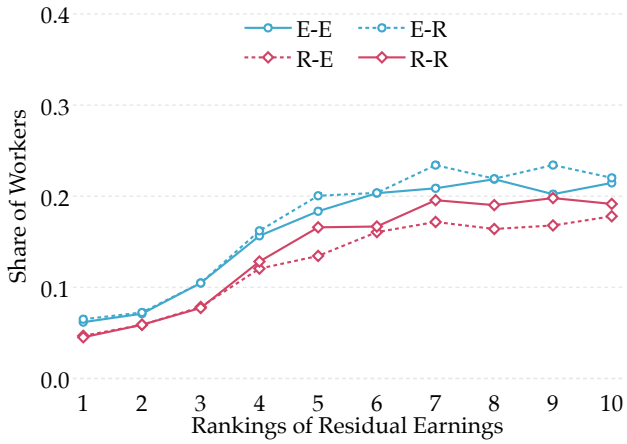
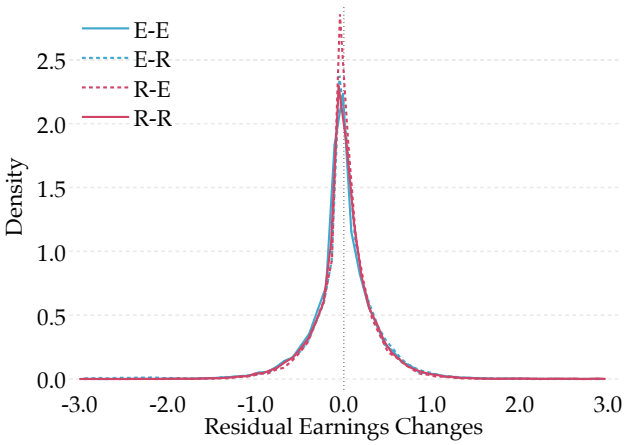


Figure 17: Conditional innovation distributions and the business cycle: Formal sector workers

(a) Formal sector stayers



(b) Formal to informal sector switchers

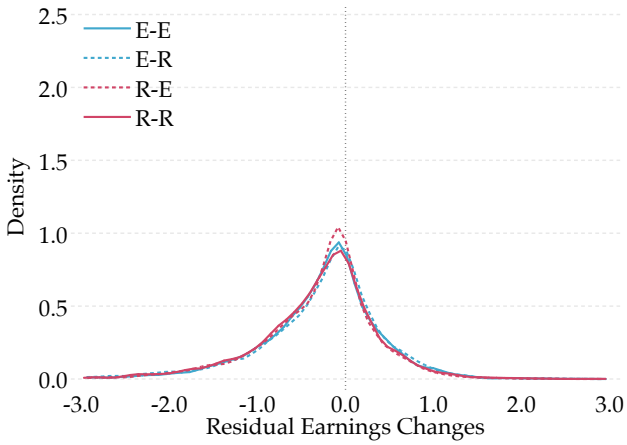
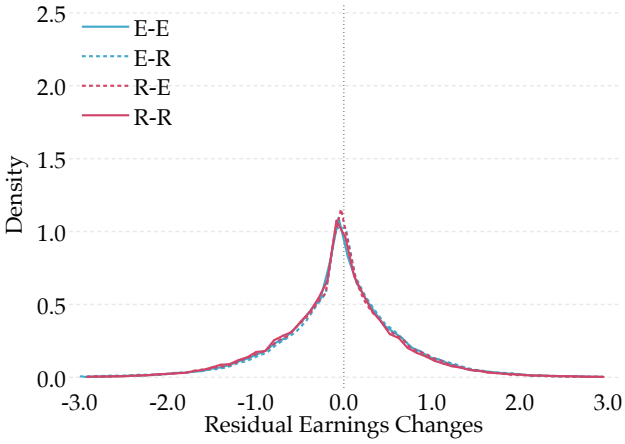


Figure 18: Conditional innovation distributions and the business cycle: Informal sector workers

(a) Informal sector stayers



(b) Informal to formal sector switchers