Transition rates and the evolution of unemployment

The unemployment rate estimated by the Continuous National Household Sample Survey (PNADC) increased from 7.1% in September 2012 to 11.8% in September 2016, a period in which the employed population fell by 0.3% while the workforce and the working age population increased by 5.1% and 5.7%, respectively. In this context, this box analyzes the evolution of transition rates among the various population categories that contributed to the growth of the unemployment rate in Brazil.

Initially, a simplified transition probability model, common in the specialized literature, in which individuals can belong to only two categories (employed or unemployed), was used. In this model, the evolution of the unemployment rate is determined by the differential equation (1), which has an analytical solution for the case where the transition rates remain constant between two consecutive periods (2).

Model:
\[
\frac{du}{dt} = f_{e,u} \cdot (1 - u) + f_{u,e} \cdot u
\]

where:
- \( u \) = unemployment rate
- \( f_{e,u} \) = transition rate from employment to unemployment
- \( f_{u,e} \) = transition rate from unemployment to employment

Analytical solution:
\[
(2) \quad u(t) = \beta(t) \cdot u^* + (1 - \beta(t)) \cdot u(t = 0)
\]
\[
\beta(t) = 1 - e^{-(f_{e,u} + f_{u,e})}
\]
\[
\frac{1}{f_{e,u} + f_{u,e}}
\]

1/ This type of analysis based on population flows is common in the labor market literature and is usually referred to as “flow approach” or “the ins and outs of unemployment”.

1/
Using (2), the unemployment rate in the following quarter \((T + 1)\) is calculated from the unemployment rate in the current quarter \((T)\) and the transition rates from employment to unemployment and vice versa. Transition rates were obtained with the pairing technique (using PNADC microdata), which allows the tracking of the same set of individuals at two points in time. Although this simplified representation of the labor market captured the direction of the changes in the unemployment rate, it underestimated its magnitude in most of the quarters analyzed (Figure 1), suggesting that relevant labor market features had been suppressed.

Seeking a better fit to the observed data, an alternative, more complete model, was proposed. In this model, the population was divided into four categories:

1. Not in the working age (PNWA);
2. Not in the workforce (PNWF);
3. Unemployed (PU); and
4. Employed (PE).

The evolution of the quantity of individuals in these categories can be represented by a set of differential equations (3) which, although having no analytical solution, can be solved numerically according to the set of equations in (4).

Model:

\[
\frac{dPOP_j}{dt} = \sum_{i=1}^{4} f_{i,j} \cdot POP_i - \sum_{i=1}^{4} f_{j,i} \cdot POP_j
\]

- \(POP_j\) = number of people in category \(j\), with \(j\) from 1 to 4
- \(f_{i,j}\) = transition rate from category \(i\) to category \(j\)

2/ For more details, see box “Labor market flows in the Brazilian labor market”, published in the September 2016 Inflation Report.

3/ Persons under the age of 14 at the date of the survey.
Numerical solution:

\[ (4) \, \text{POP}_j(t + \Delta t) = \text{POP}_j(t) + \Delta t \cdot \left( \sum_{i=1}^{4} f_{i,j} \cdot \text{POP}_i - \sum_{i=1}^{4} f_{j,i} \cdot \text{POP}_j \right) \]

Unemployment rates obtained by calculating the number of individuals in each category in the T + 1 quarter, from the amounts in the quarter T and the transition rates among the four categories of this methodology, were very close to the observed unemployment rates (Figure 1), confirming that the expanded model would be a more adequate representation of the Brazilian case.

The expanded model was then used for sequential calculations of unemployment rate trajectories, maintaining one of the transition rates as observed in the first year of the PNADC series (2012) and varying the others as they occurred. The differences between the observed unemployment rate and those calculated in this way represent the effect of the deviation of each transition rate from that observed in the first year of the series. By adding these partial effects, we have obtained the combined effect of the deviations of all transition rates in relation to those of 2012.

Figure 2 shows the evolution of the accumulated effect of the deviations of the transitions rates on the unemployment rate of subsequent periods. The unemployment rate observed in September 2016 was 5.1 pp higher than the one that would have occurred had the transition rates among the various population categories remained unchanged.

As shown in Table 1, most of the growth in the unemployment rate was due to deviations in the transition rates from PE to PU, from PU to PE, and from PNWF to PU and to PE in relation to the first year of the series. The greater difficulty for the unemployed individuals to find a job and for those who were employed to remain in this condition (translated into a reduction of the transition rate from unemployment to employment and

4/ Each quarter was divided into n equal intervals (Δt = 1 / n). We observed that the results do not change significantly for n higher than 10.

5/ Again, the transition rates were obtained through the PNADC microdata pairing technique.
into an increase in the probability of employed individuals becoming unemployed) resulted in increases of 1.2 pp and 1.7 pp in the unemployment rate, respectively. In addition, the increase in the transition rates of individuals out of the workforce to unemployment and the reduction of their insertion in the employment produced together a 1.9 pp growth in the unemployment rate, representing about 38% of the total increase.

In summary, the flow approach was used to assess the contributions of changes in transition rates for the unemployment rate increase observed between 2012 and 2016. From this perspective, the increase in the unemployment rate was related to the growth in the flow of individuals from outside the workforce who could not find a job, to the increase in the flow of workers who could not reposition themselves in the labor market, and to the reduction in the flow of unemployed people who could find a job in the subsequent quarter.

**References**
