

# An Index of Precarity for Measuring Early Employment Insecurity



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## 1 Introduction

Young people have found it increasingly difficult to access work or have cycled between precarious employment, inactivity or unemployment since the stark increases in youth unemployment following on from the financial crisis of 2008 (O'Reilly et al. 2015). Therefore policy approaches have sought to address the consequences of social exclusion and “scarring effects” caused by precarious trajectories (Bell and Blanchflower 2011; Gregg and Tominey 2005; Tumino 2015). In the light of this concern, we aim at developing an index of precarity that allows us to assess the quality of early employment trajectories. At the same time, this index allows us to investigate to what extent the quality of early employment trajectories is linked with future youth employment outcomes.

A vast body of literature acknowledges the increased precarity experienced by young people in the labour market; however, there is a lack of quantitative tools able to grasp the complexity of trajectories and, at the same time, assess their effects in the long run. Filling this gap implies developing a tool that evaluates quantitatively the desirability of employment trajectories and adapts to the longitudinal feature of life-course analysis. We suggest using a modified version of the original “index of complexity” elaborated by Gabadinho et al. (2010), by applying weights to differentiate between the value of labour market transitions.

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The added value of the index of precarity is to assess the degree of insecurity of employment trajectories experienced by individuals. Furthermore, it can be used to predict, together with other covariates, to what extent the precarity embedded in complex employment trajectories has an impact on the type of labour market positions in the future. Another contribution of our index is its transferability: it can be used across ages, social groups and countries and for any transition across relevant states whose succession leads to a cumulative (dis-)advantage.

This contribution shortly presents the social challenges faced by young people in their first labour market experiences. Then it presents how the index is constructed and justifies this choice. We finally calculate the index using a dataset that comes from a study by McVicar and Anyadike-Danes (2002) on transition from school to work using the Status Zero Survey 2000. The dataset includes a time series sequence of 72 monthly labour market activities for each of 712 young people in a cohort survey. These young people, living in Northern Ireland were followed up from July 1993 to June 1999. We find that young people with precarious trajectories in the first three years after leaving school have dramatically higher risk of experiencing negative labour market positions two years later.

## 2 Rising Precarity Among Young People

Changes in the skills structure and the education provision, new forms of employment and the recent economic crisis have contributed to making youth first transitions in the labour market more unstable, complex and individualised (Mills and Blossfeld 2005; Kalleberg 2009; Smithson and Lewis 2000; Gardiner 2016). These changes, crystallised in the multifaceted phenomenon called globalisation, affect young people's first transitions directly and indirectly. Directly these have increased competition among workers and imposing a fast-changing technological environment. Indirectly the effects have affected institutions that shape young people's first employment transitions such as education and welfare systems, employment relations and family structures.

These changes have turned out to be more detrimental for those groups in the labour market with low skills and educational attainment and more likely to be discriminated, such as young people, women, ethnic minorities and migrants. Moreover young people's low negotiating power is worsened by the lack of seniority or work experience (Mills and Blossfeld 2005). According to Standing (1999) these groups have been increasingly experiencing a process of churning between various forms of employment precarity and inactivity.

Protracted experiences of precarious employment—i.e. “employment that is uncertain, unpredictable, and risky from the point of view of the worker” (Kalleberg 2009) and often of poor quality—and joblessness have become more common (Gebel 2010; Ortiz 2010; Worth 2005; Scherer 2001). These contribute to add further precarity when individuals are expected to make critical decisions that shape their life-course (Mills and Blossfeld 2005).

Volatility of employment trajectories can result in stigmatisation, negative signalling to employers. In the long run, this is likely to entail a “scarring” effect. This means that past negative and precarious experiences in the labour market can have long-term negative consequences in terms of repeated periods of unemployment, lower wages and lower levels of human capital attainment over the life cycle (Ayllón 2013; Manzonì and Mooi-Reci 2011; Cable et al. 2008; Schmelzer 2011; Weich and Lewis 1998), but also in terms of well-being (Daly and Delaney 2013).

Rising levels of precarious forms of employment as typified in the UK by zero hours contracts where working hours are not guaranteed (Bussi and O’Reilly 2016) or mini-jobs in Germany (Palier and Thelen 2010) are a reflection of this increasingly fragmented and fragile labour market. In these circumstances Schmid and Schömann (2004) have argued that it is more useful to think of (early-) employment insecurity rather than of (early-) job insecurity. Employment insecurity is better at capturing how precarity affects labour market integration and how individual negotiated choices are embedded in multiple changes and transitions over time. Employment security can involve changing employer and job but maintaining an employment relationship and stable income (Chung and Van Oorschot 2011). Schmid (2015) argues that the welfare state needs to actively contribute to secure employment over the life course rather than a focus on job security. Employment security requires an investment in skills to reinforce employability and access to work (Muffels and Luijkx 2008).

On the basis of this body of literature, we propose to develop an index of precarity to capture a range of labour market precarity comprehensively and test the hypothesis that young persons will be unemployed, inactive or in temporary employment in latter periods if they have a trajectory dominated by non-employment or precarious employment.

### 3 Conceptualising Precarity

Measuring precarity and its impact is not straightforward. Barbier (2005) explains that the experience of employment precarity does not translate in the same way across institutional and cultural contexts. Most of the existing literature has focused on different aspects of precarious experiences in the labour market: among others the quality of jobs (Leschke and Watt 2008); the capacity of precarious work contracts acting as bridges towards more stable jobs (Booth et al. 2002; Scherer 2004; de Graaf-Zijl et al. 2011; Cockx and Picchio 2012); and the impact of precarious work on health and well-being. Furthermore, studies on the impact of spells of inactivity and unemployment have mostly looked at single spells, or cumulative spells of unemployment/inactivity. They have rarely assessed the disadvantage derived by a succession of negative spells and downward changes in the labour market, i.e. of a protracted precarity.

Our index aims to provide a quantitative tool accounting for the cumulative process of precarity and its impact. Different summaries of a sequence more or less related to employment precarity can be found in the literature. The diversity

of the states visited, i.e. here of the labour market positions experienced, is often considered as an indicator of the uncertainty—in the sense of unpredictability—of the trajectory. It can be measured, for example, by the entropy (lack of predictability) of the distribution of the states within the sequence or by the inverse of the variance of the time spent in the successive distinct states. However, such measures do not account for the sequencing, i.e. order of the states. For example, the sequences *FFUU* and *FUFU* have same entropy but the order of states is different. At least two composite measures that combine a diversity indicator with something sensitive to this sequencing have been proposed in the literature. The turbulence index of Elzinga and Liefbroer (2007) combines the inverse of the variance of the durations in the distinct successive states with the number of subsequences that can be extracted from the sequence of distinct successive states. The complexity index of Gabadinho et al. (2010) combines entropy with the number of transitions in the sequence.

These indexes are intended to measure the unpredictability or instability of sequences, but this is done without taking the nature of the states into account. For example, letting *E*, *W*, and *U* stand for education, work, and unemployment, the sequences *EEWWW* and *EEUUU* would get the same entropy, turbulence and complexity values, while the second is evidently a more precarious trajectory.

Although sequence instability as measured by the turbulence or complexity index certainly contributes to understanding the precarity of a sequence, a precarity indicator has to account for the nature of the states that constitute the trajectory. A first simple solution is to distinguish between positive (e.g. employed or in education) and negative (e.g. unemployed) states like in the volatility indicator of Brzinsky-Fay (2007). This indicator is defined as the ratio between the number of positive and negative positions in the sequence. Based on this same distinction between positive (success) and negative (failure) states, Manzoni and Mooi-Reci (2018) propose a refined solution where precarity increases with the recency of failures. However, these two solutions do not explicitly account for the instability of the sequence.

A general approach to get a precarity index accounting for both the instability of the sequence and the nature of the states is to apply a correction factor based on the nature of the states to any measure of sequence instability. For example, we would get such an indicator by multiplying either the turbulence or the complexity index by Brzinsky-Fay's volatility indicator.

Instead of just distinguishing between positive and negative states, we could assign degrees of precarity to the different states. A temporary job would, for instance, get a higher degree of precarity than a full time job and a lower degree compared to unemployment. Moreover, the precarity of a trajectory depends on the evolution within the sequence and we should, therefore, not only account for the nature of the states but also for the type of the state transitions—changes of states—in the sequence.

Here, we consider that the precarity of a sequence

1. increases with the sequence instability due to the lack of predictability of the different states experienced;

2. increases with the proportion of downward transitions in the sequence, i.e. proportion of transitions to a less favourable state, and decreases with the proportion of upward transitions;
3. increases with the precarity degree of the starting state.

In addition, we consider that the transitions may have different advantageous or disadvantageous degrees that should be taken into account when computing the proportion of negative and positive transitions. For instance, we could consider that a transition from full time employment to unemployment is more damaging than a transition from a full time to a part time job. We would also expect that a transition from full time to unemployment generates a higher precarity weight than a transition from a temporary job to unemployment when the former is less likely to occur than the latter.

## 4 The Precarity Index

We use the complexity index (Gabadinho et al. 2010, 2011) as a measure of the sequence instability and propose to qualify—penalize/reward—it by means of a correction factor derived from the proportions of negative and positive transitions in the sequence.

### 4.1 Defining the Index

The index of complexity of a sequence is a composite index defined as the geometric mean between the normalized entropy of the sequence and the normalized number of transitions in the sequence. The entropy is normalized by dividing it by the logarithm of the size of the alphabet, i.e. the logarithm of the number of all possible states that the person can experience, which is the maximal possible entropy given the alphabet. The number of transitions is normalized by  $\ell - 1$ , i.e. the length of the sequence minus one. Formally, the complexity  $c(s)$  of a sequence  $s$  reads

$$c(s) = \sqrt{\frac{h(s)}{\log(n_a)} \frac{nt_s}{(\ell_s - 1)}}$$

where  $h(s)$  is the entropy,  $n_a$  the size of the alphabet,  $nt_s$  the number of transitions, and  $\ell_s$  the length of the sequence.

Now, assuming the states—the labour market positions—can be ordered from the best to the worst state (see Sect. 4.4 for how to relax this strict order requirement), we say that a state transition  $A \rightarrow B$  in a sequence is negative when there is a deterioration, i.e. when the difference  $\text{rank}(A) - \text{rank}(B)$  between the ranks of the origin and destination states is negative. Likewise, the transition is said positive

in case of improvement, i.e. when  $\text{rank}(A) - \text{rank}(B) > 0$ . Letting  $q^-(s)$  be the (weighted) proportion of negative transitions in the sequence  $s$  and  $q^+(s)$  the (weighted) proportion of positive transitions, we define the correction factor in terms of the difference between the two:

$$q(s) = q^-(s) - q^+(s).$$

Since  $q^-(s)$  and  $q^+(s)$  are proportions, we have  $-1 \leq q(s) \leq 1$ . The correction factors will be  $1 + q(s)$  and the proposed qualified complexity index reads

$$\text{prec}(s) = \lambda a(s_1) + (1 - \lambda) c(s)^\alpha (1 + q(s))^\beta \quad (1)$$

where  $c(s)$  is the complexity index of the sequence and  $a(s_1) \in [0, 1]$  the starting cost, i.e. the degree of precarity associated to the starting state  $s_1$  in the sequence. The correction factor  $(1 + q(s))$  is non negative. It is greater than 1 when  $q(s)$  is positive, i.e. when there are more negative than positive transitions. Thus the greater  $q(s)$  the stronger the penalization of the original complexity index. The parameter  $\lambda$  serves to control the trade-off between the starting cost and the corrected complexity while the exponents  $\alpha$  and  $\beta$  control the respective importance of the complexity and the correction. The choice of the values of these parameters is addressed in Sect. 4.2.

Different variants of  $q(s)$  may result depending on whether we take into account the transition costs, and, if so, on how these costs are determined.

Let  $w(s_t, s_{t+1})$  be the cost of a transition from state  $s_t$  to state  $s_{t+1}$  over two successive time positions  $t$  and  $t + 1$ . To get  $q(s)$ , we first compute the total cost  $nw(s)$  of the successive transitions in the sequence  $s$ , the total cost  $nw^-(s)$  of the negative transitions, and the total cost  $nw^+(s)$  of the positive transitions:

$$\begin{aligned} nw(s) &= \sum_{t=1}^{\ell-1} w(s_t, s_{t+1}) \\ nw^-(s) &= \sum_{t=1}^{\ell-1} I^-(s_t, s_{t+1}) w(s_t, s_{t+1}) \\ nw^+(s) &= \sum_{t=1}^{\ell-1} I^+(s_t, s_{t+1}) w(s_t, s_{t+1}) \end{aligned}$$

where  $I^-(s_t, s_{t+1})$  is a deterioration indicator taking value 1 for state deterioration and 0 otherwise, and  $I^+(s_t, s_{t+1})$  a similar function for state improvement. The proportions of cost-weighted negative and positive transitions are then:

$$q^-(s) = \frac{nw^-(s)}{nw(s)} \quad q^+(s) = \frac{nw^+(s)}{nw(s)}.$$

## 4.2 Tuning the Index

The formula (1) has three tuning parameters  $\lambda$ ,  $\alpha$ , and  $\beta$  that allow the formula to encompass a whole family of indexes. We should chose these parameters such that  $0 \leq \lambda \leq 1$ ,  $\alpha \geq 0$  and  $\beta \geq 0$ .

The parameter  $\lambda$  determines the trade-off between the precarity of the starting state and the corrected complexity. With  $\lambda = 0$ , the precarity level of the starting state in the sequence would simply be ignored while with  $\lambda = 1$  the precarity of the whole sequence would just be that of its starting state. It seems reasonable to give less importance to the starting state than to the corrected complexity and we suggest, therefore, a value  $\lambda = 0.2$ . With this value the precarity degree of the starting state receives a 20% weight while the corrected complexity counts for 80% of the index.

Parameters  $\alpha$  and  $\beta$  are exponential weights that allow for some control on the respective importance of the complexity and the correction factor in the corrected complexity term. For instance, we would get an index that does not account at all for the complexity by setting  $\alpha = 0$ . Setting in addition  $\lambda = 0$ , the index would reduce to the mere correction factor. Likewise,  $\beta = 0$  suppresses the correction. We get unweighted effects with  $\alpha = \beta = 1$ . With  $\alpha > 1$  we increase the importance of the complexity. Likewise, a value  $\beta > 1$  strengthens the correction, which may prove useful in case we feel the correction is insufficient. We got good results in our experiments with  $\alpha = 1$  and  $\beta = 1.2$ .

Alongside the values of the tuning parameters, the analyst has also to make a choice regarding the precarity degree  $a(s_1)$  of the starting state—the offset in formula (1)—and the weights  $w(s_t, s_{t+1})$  of the transitions that impact the correction factor  $1 - q(s)$ . Different strategies can be envisaged for these choices including defining them on theoretical grounds, on the hypothesized rank order of the states, or deriving them from the data.

Regarding the precarity degree of the states to be used as  $a(s_1)$  value, a solution using the hypothesized state order is to assign the  $n_a$  equally spaced values between 0 and 1 as precarity degree to the sorted states. The  $i$ th state would in that case get a precarity degree of  $(i - 1)/(n_a - 1)$ . As a data-driven approach, we could, for example, set the precarity degree of each state as the probability to visit at least  $k$  bad states during the next  $m$  periods.

Likewise, referring to the rank order of the states, we could set the costs  $w(s_t, s_{t+1})$  of the transitions as the difference between the ranks of the origin and destination states. Data driven approaches for the transition costs could be for instance

1. Give higher cost weights to rare transitions by defining the weight of each transition as a decreasing function (e.g.  $1 - p$ ) of its estimated transition probability  $p(s_{t+1}|s_t)$ . Here, we could either compute this probability on the original sequences or ignore the durations of the successive states in the sequences and compute the probabilities of transition on the sequences of distinct successive states (DSS).

2. Define the cost of each negative transition as the estimated probability to be in a bad state say  $k$  periods after the transition, and for each positive transition as the estimated probability to be in a good state  $k$  periods after the transition.

For the illustrative example in Sect. 4.3 and the application in Sect. 5, we retain the values  $\lambda = 0.2$ ,  $\alpha = 1$ , and  $\beta = 1.2$ , set the precarity degree  $a(s_1)$  as the  $n_a$  equally spaced values between 0 and 1, and we use the complement to 1 of the transition probabilities in the DSS sequences as transition costs.

### 4.3 Behavior of the Precarity Index

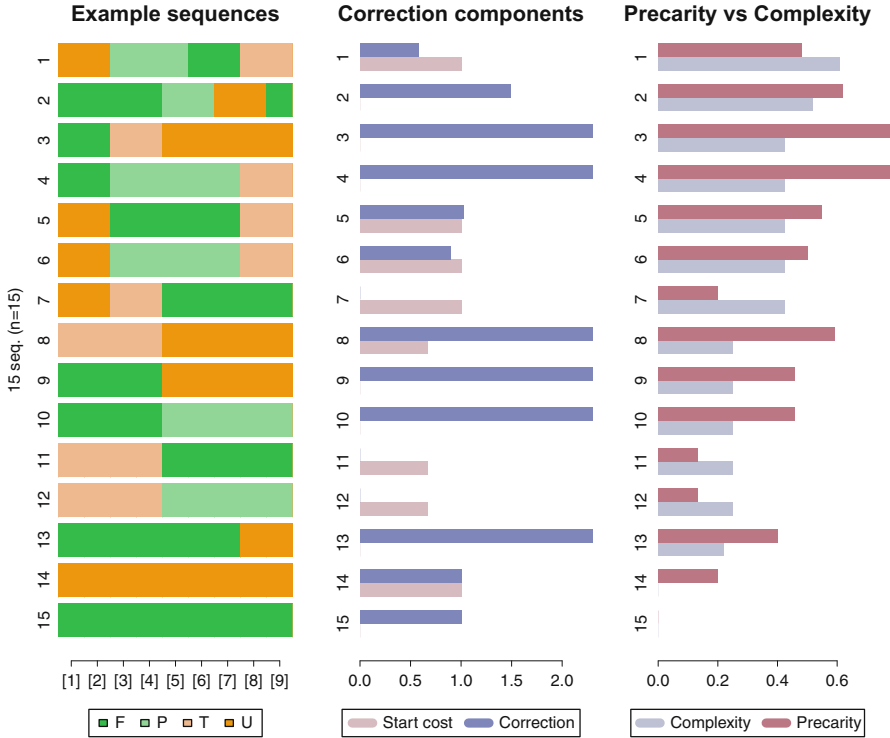
To illustrate the behaviour of the index, we consider the set of fictitious sequences shown in Table 1 where the states are  $F$ , Full time permanent employment,  $P$ , Part time,  $T$ , Temporary employment,  $U$ , unemployment, and  $I$ , inactivity. We assume that there is a decreasing hierarchical order of the first four states, namely  $F, P, T, U$ . We also assume that  $I$  is neither better nor worse than the other states and can therefore not be classified.

So far we have assumed the states are strictly ordered. Therefore, we consider for now only the first 15 sequences where the non-comparable state  $I$  does not appear. In Table 1, the first two sequences are the most complex with three transitions each. The first one is slightly more complex with four different states as opposed to three states in the second sequence. Nevertheless, the second looks more precarious with two downward transitions compared to only one in the first sequence. Sequences 14 and 15 are composed of only one state. They have a zero complexity degree. However, sequence 14 in which the stable state is unemployment

**Table 1** Example dataset

	Sequence		Sequence
1	U/2-P/3-F/2-T/2	16	F/3-T/3-I/3
2	F/4-P/2-U/2-F/1	17	T/4-I/2-P/3
3	F/2-T/2-U/5	18	T/3-P/3-I/3
4	F/2-P/5-T/2	19	F/5-P/2-I/2
5	U/2-F/5-T/2	20	I/3-P/3-I/3
6	U/2-P/5-T/2	21	F/4-I/5
7	U/2-T/2-F/5		
8	T/4-U/5		
9	F/4-U/5		
10	F/4-P/5		
11	T/4-F/5		
12	T/4-P/5		
13	F/7-U/2		
14	U/9		
15	F/9		





**Fig. 1** Precarity and its components under the strict state order assumption

(*U*) looks more precarious than sequence 15 composed of one favourable state (*F*, full-time employment). We expect the index of precarity to reflect these differences in quality and complexity.

The values of the precarity index (computed with  $\lambda = 0.2$  and  $\beta = 1.2$ ), as well as of the complexity index are shown in the right panel of Fig. 1. In the middle panel the figure shows for each sequence *s* the starting cost  $a(s_1)$ , i.e. the precarity degree of the first state in the sequence, and the correction factor  $(1 + q(s))^\beta$ .

The index behaves as expected regarding the first two sequences: The second sequence gets a slightly higher precarity value than the first despite its lower complexity. Sequence 14 with zero complexity—i.e. no transitions—gets a non-zero precarity value because the cost of its starting state—*U*, being unemployed—is high in terms of precarity. This is not the case for sequence 15 the other sequence with zero complexity, which starts off with employment, i.e. zero cost in terms of precarity. We observe that the sequences with highest precarity are not the more complex ones but those with only negative transitions. The index of precarity is highest for sequences 3 and 4. It is slightly lower for sequences 8, 9, 10 and 13 that also have only negative transitions, but lower complexity due to only one transition. In addition, as expected sequences with only positive transitions (7, 11, 12) get low values of precarity.

#### 4.4 Relaxing the Strict State Ordering Requirement

A strict order of the states is hardly compatible with the complexity of reality, especially when some states could not be clearly ranked with respect to the others (e.g. should education be considered as worse or better than employment?). We consider two situations that depart from the strict state order assumption: equivalent classes of states and non-comparable states.

A *class of equivalent states* is a subset of states that are considered equivalent, i.e. states with no ordering between them. In our example,  $F$  and  $P$  could be considered as equivalent if we assume that the choice between a full-time and a part-time job is a pure employee's choice.

A *non-comparable state* is a state that cannot be ordered, i.e. a state that is neither better nor worse than any other state. This is the case of the inactivity state  $I$  in our example.

We need solutions to handle these cases at two levels: for the computation of the proportions of negative and positive transitions, and for determining the state costs in the case where we want to derive them from the state order as we do in our example.

For equivalent classes, we do not penalize or reward any transition between states of a same equivalent class. In other words, all transitions between elements of an equivalent class get a zero weight in the weighted proportion of negative and positive transitions. As for transitions from or to any non-comparable state, we also chose to neither penalize nor reward them by giving them zero weight. In addition, however, subsequences such as  $P III U$ , where non-comparable states—the  $I$ s in the example—occur in-between two regularly ranked states will be counted as a transition from its first element to the last, e.g.  $P III U$  is counted as a transition  $P \rightarrow U$ , i.e. as a negative transition.

Regarding starting costs based on the state order, we assign to each state (labour market position) in an equivalence class the mean cost of the states in the class, and the overall mean starting cost (i.e. 0.5) to each non-comparable state. A consequence is that in case the highest ranked state belongs to an equivalence class, its cost would be the non-zero mean value of the class and there would be no zero starting cost.

To illustrate we have computed the precarity index for the full set of sequences shown in Table 1, i.e. including those with the non-comparable state  $I$  and assuming in addition that full-time,  $F$ , and part-time working,  $P$ , form an equivalence class. We used again a trade-off value  $\lambda = .2$  and an exponent weight  $\beta = 1.2$ . Figure 2 shows the obtained precarity values and their components the complexity index  $c(s)$ , the weighted correction factor  $(1 + q)^\beta$ , and the starting cost  $a(s)$ .

Looking at the first 15 sequences, we see a few differences with what we found in Fig. 1 using the strict order assumption. We first observe that there is now no sequence with a zero precarity value. Sequence 15 that had a zero value under the strict order assumption gets now a small positive value. This is because of the equivalence class between the two best ranked states in the state order. The starting state  $F$  gets here the non-zero mean value between  $F$  and  $P$  as precarity degree.



**Fig. 2** Precarity and its components in presence of the non-comparable state  $I$  and the equivalence class  $\{F, P\}$

Considering  $F$  and  $P$  as equivalent also has consequences on the ranking of the sequences. Sequence 1 gets here a higher precarity value than sequence 2. Because of the equivalence class, the two sequences have the same number of positive and negative transitions, which is reflected by correction factors close to 1. The main difference between the two sequences is the worse starting state in sequence 1.

Among the sequences with the non-comparable state  $I$ , sequence 16 appears to be the most precarious. It is made of a single downward transition and has maximal complexity for a sequence with 3 out of 5 states. Sequences 17 and 18 have only an upward transition and get therefore low precarity values. Finally, sequences 19, 20, and 21 have only zero weighted transitions—hence a neutral correction factor of 1—and get mid precarity values.

## 5 Application to the School to Work Transition

We now show how the index can be used on a real world dataset using the Status Zero Survey data of McVicar and Anyadike-Danes (2002) on the school to work transition of young Northern Irish.<sup>1</sup> This cohort survey was used to establish a link between individual, family and school characteristics and types of trajectories. The aim was to identify those young people who are more likely to experience unsuccessful trajectories in the adult labour market. The survey provides monthly information on the labour market activities of 712 young people for 72 months (6 years) after they left compulsory schooling. Despite the fact that these data refer to the period between July 1993 and June 1999, they represent a good testing ground for our index of precarity as they focus on early employment trajectories of young people who just left education. We complete the study from McVicar and Anyadike-Danes (2002) by assessing the quality of trajectories of young people and testing whether this contributes, beyond static individual school and family characteristics, to predicting future labour market positions. This is particularly relevant in the current economic and labour market situation, where young people have been hit hard by the crisis and are often overrepresented in temporary and precarious employment.

Due to its collection structure, all individuals are aged 16 at the start of the trajectories. Here we shall ignore the first two holiday months and retain the sequences from September 1993 to June 1999, i.e. sequences of length 70. The data distinguishes between six labour market activities: school (SC), training (TR), further education (FE), higher education (HE), employment (EM), and joblessness (JL).

We use the dataset to study how the degree of precarity of the trajectory during the first 36 months—from September 1993 to August 1996—impacts the situation of the young person two years later, i.e. the 6th year after the end of compulsory school. Hence, we aim to measure the scarring effect of early precarious trajectories in mid-term labour market outcomes. More specifically, we examine the chances to be at least one month in one of the states JL, TR, or SC during this 6th year, i.e. between September 1998 and June 1999.

In order to study the precarity of the trajectories during the first 36 months, we consider the three equivalence classes:

$$C_1 = \{\text{FE, HE, EM}\}, C_2 = \{\text{SC, TR}\}, C_3 = \{\text{JL}\}.$$

In addition, we assume the decreasing order  $C_1 > C_2 > C_3$  of the equivalent classes. Thus, for example, changing from employment (EM) to training (TR) will be considered a downward transition, a change from school (SC) to further education (FE) as an upward transition, and a change from further education (FE) to employment (EM) as neutral.

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<sup>1</sup>The data ship with the R package TraMineR (Gabadinho et al. 2011).

**Table 2** Weights based on transition probabilities in the DSS

	→EM	→FE	→HE	→JL	→SC	→TR
EM→	0.00	0.00	0.00	0.67	0.94	0.75
FE→	0.00	0.00	0.00	0.81	0.97	0.90
HE→	0.00	0.00	0.00	0.80	1.00	1.00
JL→	-0.44	-0.80	-0.97	0.00	-0.99	-0.80
SC→	-0.68	-0.83	-0.68	0.87	0.00	0.00
TR→	-0.30	-0.93	-1.00	0.78	0.00	0.00

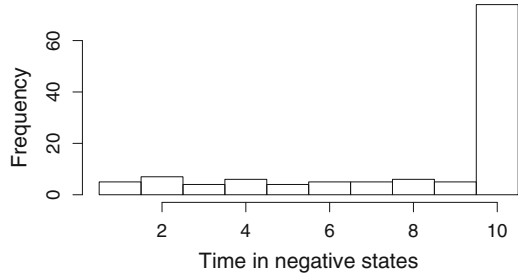
**Table 3** Ten sequences with highest precarity value

Id	Sequence	Prec
705	FE/10-TR/12-EM/11-TR/3	0.38
98	SC/8-JL/4-FE/10-JL/2-FE/10-EM/2	0.39
70	FE/22-EM/2-TR/10-JL/2	0.39
110	TR/5-JL/2-EM/6-JL/6-EM/17	0.39
634	SC/10-JL/1-EM/5-JL/2-EM/18	0.39
305	FE/5-JL/3-EM/2-JL/2-FE/5-JL/1-EM/11-JL/2-EM/5	0.39
377	JL/10-EM/2-JL/10-EM/2-FE/10-EM/2	0.40
520	SC/9-JL/3-FE/5-TR/19	0.42
405	SC/6-JL/6-FE/3-JL/7-TR/7-JL/7	0.45
408	SC/1-JL/2-EM/4-JL/5-FE/18-JL/4-EM/2	0.45

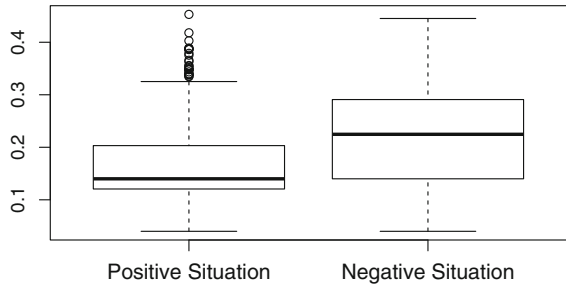
We compute the index using  $\lambda = .2$ ,  $\beta = 1.2$ , and transition weights based on the transition probabilities in the DSS. The weights are shown in Table 2. Weights of upward transitions are displayed with a negative sign to recall their reducing effect on the correction factor. Table 3 lists the ten sequences with the highest values for the precarity index. All these most precarious sequences have at least as many upward than downward transitions except sequence 377 that starts with the worst state JL. Sequence number 377 appears to be precarious because it starts with the worst state JL, i.e. a high starting cost. We can also observe that among the ten most precarious trajectories the upward transitions are typically transitions with lower weights than the downward transitions. E.g., the transition JL→EM that occurs frequently in the precarious sequences has a 0.44 weight, while SC→JL present in half of the ten sequences has almost twice that weight.

In order to predict the impact of the quality of the trajectory during the initial 36 months on the future situation we build two variables from the 10 last months of the observed sequences, i.e. months 61 to 70—September 1998 to June 1999—of our sequences. The first, *bad.dur*, is the total time spent in one of the states JL, TR, or SC during the last 10 months (6th year), and the second is a binary variable, *is.bad*, taking value 1 when *bad.dur* > 0, i.e. when the individual has spells of negative states during the 6th year. There are 19.4% of the followed individuals who spent at least a month in a negative state, and Fig. 3 shows the distribution of the total number of months for those 121 cases. Clearly most of those who had bad spells spent all ten months in undesirable states. Figure 4 shows that the distribution of

**Fig. 3** Distribution of the time spent in negative states during last 10 months among those who experienced bad spells



**Fig. 4** Precarity degree during the first 36 months for those in a negative situation two years later versus those who are not



**Table 4** Linear regression for time in bad states during last 10 months and logistic regression for ‘More than 0 months in bad states during the last 10 months’

	Linear		Logistic	
	Estimate	Sig.	Odd Ratio	Sig.
(Intercept)	0.64	0.05	0.10	0.00
Precarity	8.10	0.00	632.77	0.00
Good End CS Qualification	-0.85	0.00	0.40	0.00
Male	-0.66	0.01	0.62	0.02

the precarity degree during the first 36 months greatly differs between those in bad situation two years later and the others.

The impact of the precarity degree can be measured through a logistic regression using *is.bad* as the dependent variable and the precarity as predictor. Table 4 shows the effect of the precarity degree when controlled for two other covariates, namely whether students gained good qualification at the end of compulsory school (*gcse5eq*) and whether they are males (*male*). The results evidently demonstrate the strength of the precarity degree of the early trajectory as predictor of the future situation. An increase of the precarity index by 0.1 unit for example multiplies the odd of experiencing a negative situation a few years later by about 60. From the linear regression, an increase of the precarity degree during the first 3 years of 0.1 unit leads on average to an increase of the time in negative states during the 6th year by almost one month.

## 6 Conclusion

In this study, we set out to develop an index to quantify the degree of precarity of individual sequences and to predict future insecurity in professional careers. Starting from the assumption that the complexity of the sequence contributes to the precarity of the trajectory, we have defined the index as a corrected complexity index. There is a multiplicative correction based on the difference between the proportions of downward and upward transitions in the sequence and an offset correction to account for the degree of precarity at the start of the sequence. Despite its relative simplicity, the index proved to be able to effectively grasp precarity. Using the data from McVicar and Anyadike-Danes (2002) on the school to work transition of school leavers in Northern Ireland, we also demonstrated the usefulness of the index for studying how precarity during the first years after compulsory schooling impacts future outcomes. There is certainly room for further improvements, for instance, by accounting for the time elapsed between transitions and/or the timing of the transitions. The concept of recency used by Manzoni and Mooi-Reci (2018) for their own quality index is also an interesting dimension to consider.

The precarity index is very flexible and can be tuned by choosing the transition weights, the degree of precarity of the starting costs, the trade-off parameter  $\lambda$ , and the exponent weights  $\alpha$  and  $\beta$  that determine the respective importance of the complexity and the correction factor. These weights and parameters offer the analyst the possibility to adapt the index to specific contexts. However, making choices is not indispensable. The index provides most often sensible results with default parameter values and automatic methods for setting transition weights and starting precarity degrees. The only necessary information that the user has to specify is the rank order of the states with possible equivalence classes and non comparable states.

Although the indicator was specifically developed for measuring the precarity of sequences of labour market activities in order to predict future insecurity in professional careers, the index could as well be used for sequences of other domains of the life course such as family or health trajectories. The only requirement is the existence of some (partial) order between the states of the alphabet adopted, i.e. at least some states should be preferable to some others. Moreover, it could also be of interest to use the index as the dependent variable to study how precarity depends on personal characteristics such as sex, social origin or previous educational trajectory.

The index has been implemented as a beta version in TraMineRextras and should be made available in a next release of TraMineR (Gabadinho et al. 2011).

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