

Income Loss and COVID-19: Evidence from Tunisia

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ABSTRACT

The purpose of this study is to analyze and to predict the individuals' income loss associated with education, job sector, income brackets during the COVID-19 pandemic in the Tunisian context. A direct survey was conducted in 1842 Tunisian active worker and self-employment aged over 20 years (mean=35.61% female) between December 20, 2020, and February 8, 2021 in Grand Tunis region. Multinomial logistic regression had been used to assess the COVID-19 impact on an individual's income change in the Tunisian context. The education attainment, job sector and income level had been mobilized to explain the income loss. We find that the education attainment, job sector and income predictor variables are statistically significant. In particular (1) the log-odds will decrease of being in 'Partial Income Loss' versus 'No Income Loss' class if the responder has a university degree. (2) The log-odds of being in 'Partial Income Loss' class relative to 'No Income Loss' class will increase if the individual is not in the Job state sector (3) The log-odds will decrease of being in 'No Income' versus 'No Income Loss' class if the responder has a secondary, or a university degree. Our predictions point out that four fifth of the responders losing their income temporarily or permanently during the year 2020. Tunisian government has to assist the vulnerable social classes and reduce the inequality between social classes.

Keywords: COVID-19 outbreak, employees, self-employed, Economic impact, Tunisia.

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I. INTRODUCTION

The severe acute respiratory syndrome coronavirus 2 (COVID-19) classified as a pandemic on 11 March 2020 by the World Health Organisation (WHO, 2020). From Wuhan to Tunis a distance of 9128 Kilometers but the pandemic propagation had endured few days. A general lockdown had been ordered by the Tunisian government to encounter the outbreak. Many workplaces had shut down such as markets, restaurants, cafés and international flights were suspended. According to the Institut National de la Statistique (INS, 2020), Tunisian economy recorded in 2020 a decline of 8.8% compared to the year 2019 due to the COVID-19 outbreak. The number of unemployed, estimated for the fourth quarter of 2020 is 725,100 of the total workforces, compared to an average of 676,600 unemployed for the third quarter of 2020 (INS, 2020).

In the second quarter of 2020, an average of 74,200 people classified out of the labor force, although they were available to restart working. This group was not counted as unemployed because they had been stopped working due to the COVID-19 pandemic (INS, 2020). However, faced with a blurred situation, no real and updated database concerning the impact of the COVID-19 outbreak on individual economic situation, it is necessary to measure and to predict outbreak's impact on individual income in the Tunisian context. For this reason, predict the socio-economic consequences of crisis is crucial to notify policymakers' decisions (Li *et al.*, 2020).

Based on previous research studies estimating the economic impact of the COVID-19 outbreak on individuals in emerging and developed countries we had motivated to

generalize the academic process in the Tunisian context (Qian & Fan, 2020; Martin *et al.*, 2020; Lemieux *et al.*, 2020; Perles-Ribes *et al.*, 2021; Dang & Viet Nguyen, 2021; Buera *et al.*, 2021; Hershbein & Holzer, 2021). The COVID-19 outbreak impacts had been measured by the income change from the baseline year 2019 to the year 2020 (Qian & Fan, 2020). The income is the common factor of those studies with a purpose to investigate the individual income loss in and pre outbreak, based on socio-economic status to assess the pandemic impact. In particular, education attainment, job sector and income level have major effect on perceived income, amid pandemic.

In the COVID-19 outbreak literature, many recent studies have used socio-economic data to analyze individual income changing (Lemieux *et al.*, 2020), small business revenues (Dauti & Dauti, 2020), and labor market fluctuations (Lemieux *et al.*, 2020; Hershbein & Holzer, 2021). Chetty *et al.* (2020) analyze the heterogeneity impacts of the COVID-19 on the economy. The study based on an incentive literature on the economics of pandemics.

Ayadi *et al.* (2020) evaluated the policy and economic measurements to mitigate the negative impacts of the COVID-19 outbreak in the Mediterranean and Africa zone. The study highlighted the heterogeneity of the responses and the preparedness of policies in South and East Mediterranean. For the case of Tunisia, the country had the lowest index in preparedness and policy responses to curb the socio-economic vulnerability. In addition, (Qian and Fan, 2020) predicted the change of income before and in the COVID-19 outbreak by socio-economic predictor variables such as education level, family income and job sector. The results show that 48% of participants had been lost partially their

income versus 18% for no income realized. In contrast, individuals, with less than high school level education, have twice the odds to lose their income, than individuals with university level education (0.13 vs. 0.06).

Human Capital Theory has considered that education is a principal key for economic growth. For example, education is a lever for increasing opportunities and well-being of individuals. It contributes to social stability and stimulates long-term economic growth. However, during the economic crisis period the graduated their targets are any job position than a career prosperity (Gillies, 2017).

The education attainment rate is 97.8% for Grand Tunis. Individual education factor was classified into three levels; primary (baseline), secondary and university to assess education level associated with COVID-19 impact on income loss. Jiang *et al.* (2013) proposed two characteristic levels to predict the employees' perception and reaction to job insecurity. They devised the predictor variables into worker and employment characteristics. The study founded that job sector and job tenure are significantly depended to job security. According to the U.S. Bureau of Economic Analysis, the most individuals in employment sector lost their revenue during COVID-19 outbreak are in construction, retail trade, transportation, manufacturing and wholesale trade with an income drop from 10% to 80%. In contrast, the government job sector remains secure and absence of risk loose (Martin *et al.*, 2020). Perles-Ribes *et al.* (2021) analyzed and predicted the COVID-19 impact on tourist and non-tourist employment in Spain with a decrease by -14% for both sectors. Lemieux *et al.* (2020) concluded a reduction by 15% in employment due to the COVID-19 impact on the Canadian context. The industry, accommodation and food sectors are the hardest hit by the outbreak.

Furthermore, the asymmetric treatment of the self-employed by the UK government in the COVID-19 period was a study conducted by (Yue & Cowling, 2021). The authors founded a direct deterioration of the self-employed well-being suite income reduction compared to waged workers.

For the job sector, we classified it into four sectors. Our reference or baseline is the State sector, the second is the industry sector, the third is the Self-employment and the last is the Services sector.

Lemieux *et al.* (2020) measured the initial impacts of the COVID-19 outbreak on the labor force in the Canadian context. The study reports that individuals with low income are vulnerable to lose their jobs by 50% of the same income class. In India, during the outbreak, income declines by 40% compared to the reference year 2019 (Gupta *et al.*, 2021). Martin *et al.* (2020) evaluated the socio-economic impact of COVID-19 on individuals using the income quintile to explain the consumption loss in California State (San Francisco Bay Area). They concluded that the total consumption losses increase with higher income individuals. In addition, the average consumption loss equals to 18.3% of the lowest income quintile. In addition, (Qian & Fan, 2020) mobilized the family income variable for the reference year 2019 to capture the impact of COVID-19 outbreak on the changes in income. Individuals with higher family income have a lower risk of income loss with a predicted probability of 5%.

The impact of the COVID-19 outbreaks on the individual economic situation, measuring by income, has not been investigated in the Tunisian's context.

The main purpose of this study was to investigate the COVID-19 effects on an individual's economic situation. Using a large sample of participants in Tunisia, we examined the impact of COVID-19 on income stability between the baseline year 2019 and the year 2020 with three categories were used: no income loss, partial income loss and no income (Qian & Fan, 2020). The individual income situation had been depending on socioeconomic status (education attainment, job sector and income level).

At this level, we can formulate the following hypotheses predicting income losses during the COVID-19 outbreak with the reference year 2019:

H₁: Amid COVID-19 outbreak, individuals with high education level had more log-odds to maintain their income source than low level.

H₂: Amid COVID-19 outbreak, individuals in the employment sector, except State sector, had fewer log-odds to maintain their income source.

H₃: Amid COVID-19 outbreak, individuals with high income had more log-odds to maintain their income than low and middle income levels.

II. DATA AND METHODS

The survey was conducted from December 20, 2020, to February 8, 2021. The sample size was 2230 participants in Grand Tunis region (*Tunis, Ariana, Ben Arouss and Manouba*). The region was being chosen according to various criteria (1) the Grand Tunis classified as the worthiest region in Tunisia, with 36% of the country's GDP, presents 2% of the territory of the country (2) the population of the region represents 24% of the total population of Tunisia. We excluded the cases with the respondents declared that 'No Income' for the two consecutive years 2019 and 2020. The filter question had led to obtain 1842 respondents for final sample (systematic sample). To examine the impact of the COVID-19 outbreak, we asked a main question about the income changing before (year, 2019) and during the pandemic (year, 2020). The individual income statement was investigated by asking the responder the flowing question 'What is your Income situation compared to the year 2019?' The responses were three categories 'No Income Loss', 'Partial Income Loss' and 'No Income'. Another set of questions based on social-economic status, such as Education level, Job sector, Income, Marital status, Children in charge and Age. With 'nnet' R-package, we fit the multinomial logistic regression models with neural networks rather than using a Poisson model. If the regressand is a factor, an adequate classification network is structured, one output for two level number (Venables & Ripley, 2002). In multinomial logistic regression model analysis, both odds and ratios of odds are used, so the log odds are a more natural transformation than odds (Christensen, 1997). Then, we used the Wald tests to calculate the *p-values* and to validate the hypothesis. Finally, we predict the income losses prognostic by outcome class.

We are modeling the change of income by individuals linked to COVID-19 pandemic in Tunisia. As an approach,

we classify a categorical response variable at three levels to assess Income risk of loss from year 2019 to 2020. The level of our outcome has been graded in three categories (1) ‘No Income Loss’ (2) ‘Partial Income Loss’ and (3) ‘No Income’. For a multinomial logistic regression, we have two equations. The ‘No Income Loss’ is the natural situation to compare individuals’ income situation each other. Between three categories we need to determine a benchmark for assessing the variation in income. Each equation models the odds of a situation relative to a baseline (in this case, ‘No Income Loss’). As mentioned in methods, we eliminated cases when individuals reported ‘No Income’ for the two years. The dependent variable had to measure the impact of COVID-19 outbreak on the individual income situation.

For the Marital status variable is a dummy variable that equals 1 for Married and 0 for Single.

We include an indicator factor concerning the presence of children for the responder (yes=1; no=0).

Age category is classified into four brackets ‘20-29’(baseline), ‘30-39’, ‘40-49’, ‘50-59’.

Dang and Viet Nguyen (2021) analyzed the economic gender gap, amid the COVID-19 outbreak, across China, South Korea, Japan, Italy, the United Kingdom, and the United States. They suggested that women have more risk to lose permanently their job about 24 percent than men. However, the percentage of income falls down by 50% for women. We introduce gender as an independent variable; Gender is a dummy variable that equals 1 for women and 0 for men.

Our multinomial logistic regression model was used to predict the change in income which is the dependent variable based on three categories explained by the independent variables:

$$\begin{aligned} \text{Log} \left(\frac{P(\text{Situation} = \text{Partial Income Loss})}{P(\text{Situation} = \text{No Income Loss})} \right) &= \beta_{1,0} + \beta_{1,1}(\text{Education} = \text{Secondary}) \\ &+ \beta_{1,2}(\text{Education} = \text{University}) \\ &+ \beta_{1,3}(\text{Job sector} = \text{Industry}) \\ &+ \beta_{1,4}(\text{Job sector} = \text{Self - employment}) \\ &+ \beta_{1,5}(\text{Job sector} = \text{Services}) \\ &+ \beta_{1,6}(\text{Annual Income} = 5000 - 9999) \\ &+ \beta_{1,7}(\text{Annual Income} = 10000 - 19999) \\ &+ \beta_{1,8}(\text{Annual Income} = 20000 - 29999) \\ &+ \beta_{1,9}(\text{Annual Income} = > 30000) \\ &+ \text{Control variables} + \epsilon_1 \end{aligned} \tag{1}$$

$$\begin{aligned} \text{Log} \left(\frac{P(\text{Situation} = \text{No Income})}{P(\text{Situation} = \text{No Income Loss})} \right) &= \beta_{2,0} \\ &+ \beta_{2,1}(\text{Education} = \text{Secondary}) \\ &+ \beta_{2,2}(\text{Education} = \text{University}) \\ &+ \beta_{2,3}(\text{Job sector} = \text{Industry}) \\ &+ \beta_{2,4}(\text{Job sector} = \text{Self - employment}) \\ &+ \beta_{2,5}(\text{Job sector} = \text{Services}) \\ &+ \beta_{2,6}(\text{Annual Income} = 5000 - 9999) \\ &+ \beta_{2,7}(\text{Annual Income} = 10000 - 19999) \\ &+ \beta_{2,8}(\text{Annual Income} = 20000 - 29999) \\ &+ \beta_{2,9}(\text{Annual Income} = > 30000) \\ &+ \text{Control variables} + \epsilon_2 \end{aligned} \tag{1}$$

A. Descriptive Statistics

Table I presents a descriptive statistic of dependent and predictor variables mobilized in our model prediction. With 54.35 percent of participants reported that they lose partially their income for the year 2020. About 25.13 percent of individuals lost their income source against 20.52 percent who preserved it. The data related to our sample mentions an important observation: 59.07 percent of the participants have a primary education level, 58.58 percent included in the industry sector and 57.11 percent with bracket age between 40 and 49 year old. As is apparent from the descriptive statistics table, the majority of income concentrates in two brackets. 54.18 percent of individual sample has an income between 5000.000 dinars and 9999.999 dinars. Similarly, 16.88 percent of the sample has an income between 10000.000 dinars and 19999.999 dinars. For the three first income brackets, the aggregate percentage is 98.04.

TABLE I: DESCRIPTIVE STATISTICS FOR DEPENDENT AND INDEPENDENT VARIABLES

Variables	Total by category	% by category
Income Change Categories		
No Income Loss	378	20.52%
Partial Income Loss	1001	54.35%
No Income	463	25.13%
Education		
Primary	1088	59.07%
Secondary	674	36.59%
University	80	4.34%
Job Sector		
State sector	73	3.96%
Industry	1079	58.58%
Self-employment	631	34.25%
Services	59	3.21%
Annual Income		
<4999	497	26.98%
5000-9999	998	54.18%
10000-19999	311	16.88%
20000-29999	28	1.52%
>30000	8	0.44%
Marital Status		
Single	413	22.42%
Married	1429	77.58%
Children		
No=0	558	30.29%
Yes=1	1284	69.71%
Gender		
Male		64.39%
Female		35.61%
Age		
20-29	107	5.81%
30-39	219	11.89%
40-49	1052	57.11%
50-59	464	25.19%

III. RESULTS

A. ‘Partial Income Loss’ Relative to ‘No Income Loss’

For educational attainment, the log-odds of being in ‘Partial Income Loss’ class versus ‘No Income Loss’ class will increase by 0.244 if moving from primary to secondary education level. But the log-odds will decrease of being in ‘Partial Income Loss’ class versus ‘No Income Loss’ class of 2.962 if the responder has a university degree. The coefficients are significant (*p-value=000*), we want to reject the null hypothesis and conclude that for ‘Partial Income Loss’ class versus ‘No Income Loss’ class, the regression coefficients for **Education** have been found to be statistically different from zero.

All of the coefficients, related to Job Sector, are significant with positive slopes ($p\text{-value}=0.000$). As a result, the log-odds of being in ‘Partial Income Loss’ class relative ‘No Income Loss’ class will increase if the individuals are not in the Job state sector. We would reject the null hypothesis and conclude that the regression coefficients for **Job Sector** have been found to be statistically different from zero for.

In the same sense, for income classes all coefficients are positively significant ($p\text{-value}=000$). If the participant’s income increases from the reference income class to the income class ‘5000-9999’, the multinomial log-odds of being in Partial Income Loss class versus No Income Loss class would be expected to increase by 0.244 ceteris paribus all other variables constant. However, for the income upper than 10000 dinar the log-odds of being in Partial Income Loss class versus No Income Loss class would be expected to increase dramatically. We would reject the null hypothesis and conclude that for Partial Income Loss class versus No Income Loss class, the regression coefficients for **Annual Income** have been found to be statistically different from zero.

Concerning the control variables, only the predictor variable linked to marital status has a slope negatively significant. The multinomial logit for married individuals relative to single is 0.788 units lower for being in Partial Income Loss class versus No Income Loss class. In other words, married individuals are more likely than single to lose their income (**Table II**).

B. ‘No Income’ relative to ‘No Income Loss’

For Education predictor, the log-odds will decrease of being in No Income class versus No Income Loss class of 11.245 and 3.831 if the responder has a secondary or a university degree ($p\text{-vale}=000$). We would reject the null hypothesis and conclude that for No Income class versus No Income Loss class, the regression coefficients for **Education** have been found to be statistically different from zero.

In terms of Job Sector, coefficients related to Job Sector (except State sector), are significant with positive slopes ($p\text{-vale}=000$). Therefore, the log-odds of being in No Income class relative No Income Loss class will increase if the individuals are not in the Job state sector. We would reject the null hypothesis and conclude that the regression coefficients for **Job Sector** have been found to be statistically different from zero for.

In addition, for income classes all coefficients are statistically significant ($p\text{-value}=000$). The income of participants is in the income classes ‘5000-9999’ and ‘>30000’, the multinomial log-odds of being in No Income class versus No Income Loss class would be expected to decrease by 1.857 and 1.857 respectively. However, for the income in classes ‘10000-19999’ and ‘20000-29999’, the log-odds of being in No Income class versus No Income Loss

class would be expected to increase dramatically by 13.076 and 11.965 respectively ($p\text{-value}=000$). We would reject the null hypothesis and conclude that, for the ‘Partial Income Loss’ class versus the ‘No Income Loss’ class, the regression coefficients for **‘Annual Income’** have been found to be statistically different from zero.

As in the previous model for the control variables, only the predictor variable linked to marital status has a slope negatively significant. The multinomial logit for married individuals relative to single is 0.780 units lower for being in No Income class versus No Income Loss class (**Table II**).

TABLE II: MULTINOMIAL LOGISTIC REGRESSION MODELS PREDICTING LOGG-ODDS OF PARTIAL INCOME LOSS AND NO INCOME DURING COVID-19 EPIDEMIC

	Partial Income Loss	No Income
Education		
Primary (baseline)		
Secondary	0.244*** (0.092)	-11.245*** (0.100)
University	-2.962*** (0.206)	-3.831*** (0.237)
Job Sector		
State sector (baseline)		
Industry	37.216*** (0.161)	29.614*** (0.168)
Self-employment	36.945*** (0.092)	40.422*** (0.100)
Services	39.067*** (0.206)	33.234*** (0.237)
Annual Income		
<4999 (baseline)		
5000-9999	1.990*** (0.196)	-1.857*** (0.170)
10000-19999	18.370*** (0.196)	13.076*** (0.170)
20000-29999	17.383*** (0.548)	11.965*** (0.548)
>30000	18.494*** (0.000)	-1.857*** (0.000)
Marital Status		
Single (baseline)		
Married	-0.788*** (0.289)	-0.780* (0.320)
Children		
No=0 (baseline)		
Yes=1	0.292 (0.261)	0.172 (0.299)
Gender		
Male (baseline)		
Female	0.257 (0.150)	0.023 (0.172)
Age category		
20-29 (baseline)		
30-39	-0.236 (0.409)	-0.118 (0.432)
40-49	0.189 (0.367)	0.196 (0.386)
50-59	0.400 (0.371)	0.292 (0.392)
Constant	-37.231*** (0.265)	-27.388*** (0.264)

Note: Baseline is the reference category. *** p < 0.001; ** p < 0.01; * p < 0.05. Standard Error is in parenthesis.

TABLE III: ACCURACY, PRECISION AND RECALL FOR THE INCOME CHANGE BY CATEGORY

	Predicted	No Income Loss	Partial Income Loss	No Income	
Actuals	1842	378	1001	463	
No Income Loss	80	77	2	1	Recall 96.25%
Partial Income Loss	1265	203	950	112	75.10%
No Income	497	98	49	350	70.42%
Precision		20.37%	94.91%	75.59%	Accuracy= 74.75%
Right prediction					
Wrong prediction					

Parallel to Table II, we predicted the income change by the three-category of the dependent variable in Table III.

The accuracy of our model is quite good with 74.75% of predictions being correct. For the precision, we have to respond to the following question: what proportion of the changes in the income was actually correct? For the 'Partial Income Loss' prediction is the relevant class compared to 'No Income Loss' and 'No Income' with 94.91%, 20.37% and 75.59% precision ratio respectively. In addition, only 51 individual cases in 'Partial Income Loss' are misclassified. Therefore, 'No Income Loss' has been degraded from 378 actual cases to 80 predicted cases.

For the sensibility, we use the recall ratio to measure the proportion of actual income change identified correctly. 'No Income Loss' category has higher sensitivity with 96.25% compared to 'Partial Income Loss' and 'No Income' categories.

IV. DISCUSSION AND CONCLUSION

This study is an opportunity to investigate the effect of COVID-19 outbreak, in the Tunisian context and on individual income loss depending on socio-economic factors. The results are relevant due to a wide range of information. The 'Partial Income Loss' and 'No Income' group are over four-fifths of our sample. Compared to the year 2019, individual income earning in the 2020 is decreased dramatically. This scope may be highlighting the economic impact of the pandemic on individual income loss. Therefore, we formulated three hypotheses related to education attainment, job sector and income earning. Testing the first hypothesis, we found that individuals with high education level had more odds to maintain their income source than low education level. The second hypothesis related to job sector confirm that the log-odds to lose income partially or in its entirety increases, for the two categories 'Partial Income Loss' and 'No Income' versus the reference category 'No Income Loss', if the responder does not work in the State job sector. The third hypothesis shows that the impact of the COVID-19 on all income levels except for the two income brackets '5000-9999' and '>30000' with negative slopes. In addition to the main results, we measured the accuracy, precision and recall of the model. We founded that the model is accurate by 74.75%. In addition, the trade-off between precision and recall proves that 'Partial Income Loss' is well predicted and identified correctly.

This study contributes to the body of knowledge by analyzing and predicting the income loss amid the COVID-19 outbreak. The crisis exacerbated the socio-economic situation already unstable with 80 percent of the responders were lost their income temporary or definitely. To mitigate to this crisis the Tunisian government should assist individuals with economic challenges.

The limitations of this study are that (1) we used a small number of individuals working in the state job sector (2) we use data from one region (Grand Tunis) despite dividing Tunisia into eight regions (3) For the timing and duration of the survey. Given it used as a reference sector that we should increase this type of observations. Furthermore, the model could be modified by introducing other reference category for the predictor variables for accurate prediction.

We should assess the direct impact on poverty and inequality observing the number of poor increased dramatically. The long-term economic impacts of the COVID-19 outbreak could lead to financial distress and social disturbance.

This research aimed to assess and to predict the economic impact of the COVID-19 outbreak on individual's income situation. Based on a quantitative analysis of income changing in response to socioeconomic status with a large sample of the active work force in Tunisia, it can conclude that education attainment, job sector and income level are the more important factors to predict the loss of individual income. The results indicate that individuals with higher education degrees, working in the state sector are more likely to maintain their income.

This study supports the direct, negative relationship between educational level and income losses during COVID-19 pandemic.

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