The impact of fiscal policy on income mobility and poverty dynamics

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Abstract

The literature on the relationship between fiscal policy and welfare dynamics is limited. This paper provides a framework to evaluate the impact of fiscal policy on poverty dynamics and income mobility. The framework involves three sequential steps. First, prefiscal and postfiscal incomes are determined following a fiscal incidence methodology. Second, indicators of poverty dynamics, i.e., chronic poverty and transient poverty, and (directional) income mobility are separately calculated based on prefiscal and postfiscal incomes. Lastly, indicators of fiscal policy impact on welfare dynamics are defined to determine whether the fiscal system is decreasing or increasing poverty dynamics and income mobility. An empirical application using 2011 and 2014 Niger household panel data reveals that the overall effect of the country’s fiscal system on welfare dynamics is negative: chronic poverty increases by 3.18 percentage points and income mobility decreases by 20.37 percent due to fiscal policy.

Keywords

Chronic poverty, Fiscal policy, Income mobility, Transient poverty

Classification codes

D31, H31, I32
1 Introduction

Fiscal policy is a powerful instrument that the government has at its disposal to fight poverty and promote equity. For example, the government can take revenues from rich people through taxes and direct them to social spending for the poor. Poverty and inequality will fall significantly in the long run if the rich bear all the burden of taxation and the poor get all the benefits from social spending. However, in reality, the poor bear a nonnegligible part of the tax burden and the rich get a high share of public spending (Lustig, 2016). Therefore, it is important to evaluate the effects of fiscal policy to inform on whether the Government is contributing effectively to the reduction of poverty and inequality.

The aim of this paper is to provide a framework to evaluate the impact of the fiscal system on poverty dynamics and income mobility. Because poverty affects individuals differently, i.e., some are poor for a short period, while others are poor for a long one, and income movements may be positive for some people (increase of real income over a period) and negative for others (decrease of real income over a period), analyzing the impact of fiscal policy on poverty dynamics and income mobility can substantially contribute to the design of fiscal policy that effectively reduces poverty and inequality.

This study is related to an extensive literature on income mobility, poverty dynamics and fiscal policy impact. Baulch and Hoddinott (2000) present a conceptual framework for the analysis of poverty dynamics in developing countries. They define two categories of the poor, those who are always poor (chronic poor) and those who move in and out of poverty (transient poor). Fields (2005) surveys the literature on income mobility. The author distinguishes six income mobility concepts. They are as follows: time-dependence, which measures the extent to which economic well-being in the past determines individuals' economic well-being at present; positional
movement, which is the measure of individuals' changes in economic position (ranks, centiles, deciles, or quintiles); share movement, which arises when individuals' shares of the total income change; income flux, which is gauged when the focus is the size of the fluctuations in individuals' incomes but not their sign; directional income movement, which is the measure of how many people move up or down by how many dollars; and mobility as an equalizer of longer-term incomes, which involves comparing the inequality of income at one point in time with the inequality of income over a longer period\(^1\).

Fiscal policy impact has been widely assessed through fiscal incidence analysis in the literature. This analysis consists of determining prefiscal incomes (incomes before the intervention of the fiscal system) and postfiscal incomes (incomes after the intervention of the fiscal system) and comparing the welfare (measured by poverty or inequality indicators) of the population based on the two income concepts. While it is easy to compare the welfare of the population based on the prefiscal and postfiscal incomes, distinguishing the former from the latter is not straightforward. Essama-Nssah (2008) argues that the determination of prefiscal and postfiscal incomes requires analytical methods that account for individual behavior and social interaction. The author reviews some of the approaches used in the literature, including reduced form regression analysis, microsimulation models, computable general equilibrium models and a combination of computable general equilibrium and microsimulation models. In addition, the Commitment to Equity (CEQ) institute has developed a comprehensive and rigorous framework for tax and benefit incidence analysis that has been widely used over the past few years for fiscal incidence analysis in both developing and developed countries (Lustig, 2016).

\(^1\) Further details on the income mobility concepts can be found in Appendix A.
Although there is a wide literature on poverty dynamics, income mobility and fiscal policy impact on poverty and inequality, the literature on the effects of fiscal policy on poverty dynamics and income mobility is limited. Lerman and Yitzhaki (1995) analyze the extent to which U.S. tax policies reduce the income gap between richer and poorer and contrast the extent to which these policies alter the rankings of individuals in overall income distribution. They show that the latter is important for understanding the effect of the 1991 U.S. tax reform. Larrimore et al. (2015) use a large panel of federal income tax data to investigate intragenerational income mobility in the U.S. They find that almost half of workers exhibit an earnings’ increase or decrease of at least 25 percent. Alloza (2017) assesses the impact of taxes on relative income mobility by exploiting exogenous variation in the marginal tax rates over a relatively long panel of data that includes several tax reforms. He finds that higher marginal tax rates reduce income mobility. Previous works, however, does not allow one to have a complete picture of the effects of fiscal policy on income mobility, because they include only taxation and not the spending side of the fiscal system. In addition, previous work does not establish the relationship between fiscal policy and poverty dynamics.

This study provides the first comprehensive analysis of how taxes and social spending affect poverty dynamics and income mobility in a country. The methodology involves three consecutive steps. At the first stage, prefiscal and postfiscal incomes are determined following the CEQ institute fiscal incidence methodology for each year of the panel data. The second step consists of separately calculating poverty dynamic indicators (chronic and transient poverty) and income mobility indicators (income flux, directional income movement, etc.) for the prefiscal incomes and the postfiscal incomes. Lastly, indicators of fiscal policy impact on welfare dynamics are defined to determine whether the fiscal system is decreasing or increasing poverty dynamics.
and income mobility. In addition, two typical indicators are defined to identify the individuals falling into chronic poverty and those escaping chronic poverty in the presence of the fiscal system. An empirical application is presented using two waves of household panel data on consumption in Niger between 2011 and 2014. The results reveal that fiscal policy increases chronic poverty by more than 3 percentage points. While 3.28 percent of the population fall into chronic poverty because of the fiscal system, only very few (0.13 percent) escape chronic poverty due to the fiscal system. Moreover, on average, the postfiscal per capita income gain between 2011 and 2014 is 1,880.5 CFA\(^2\) francs fewer than the prefiscal one, a decrease of 20.37 percent.

The rest of the paper is organized as follows. Section 2 describes the methodological framework used to understand and evaluate the effects of taxes and spending on income mobility and poverty dynamics. Section 3 presents an empirical application discussing the data used and the main results. Lastly, Section 4 concludes and discusses potential extensions.

2 Fiscal policy, poverty dynamics and income mobility: methodological framework

Consider an economy of five individuals. Their prefiscal and postfiscal incomes, as well as the fiscal policy system in place, are known for two years, i.e., 1 and 2, as given in Table 1 below. Looking at the impact of fiscal policy on poverty, and assuming that the poverty line is 5.5 CFA francs for the two years, the conclusion will be that the fiscal system increases poverty in years 1 and 2.

\(^2\) The CFA franc is the name of two currencies used in parts of West and Central African countries which are guaranteed by the French treasury
Table 1. Effects of fiscal policy on a theoretical population of five individuals (CFA franc).

<table>
<thead>
<tr>
<th>individuals</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prefiscal Income</td>
<td>5</td>
<td>7</td>
<td>4</td>
<td>10</td>
<td>8</td>
</tr>
<tr>
<td>Taxes</td>
<td>3</td>
<td>4</td>
<td>2</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td>Transfer</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Postfiscal income</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>6</td>
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<th>individuals</th>
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<td>Prefiscal Income</td>
<td>5</td>
<td>7</td>
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<td>9</td>
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<tr>
<td>Taxes</td>
<td>1</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>4</td>
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<tr>
<td>Transfer</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Postfiscal income</td>
<td>6</td>
<td>5</td>
<td>6</td>
<td>5</td>
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</tr>
</tbody>
</table>

Source: The authors

However, looking at the impact of fiscal policy on poverty dynamics\(^3\), the story will be different. For instance, the proportions of chronic poor and nonpoor decrease in the presence of the fiscal system from 40 percent and 60 percent to 20 percent and 0 percent, respectively. In addition, the fiscal system increases mobility in and out of poverty. Both poverty entry and poverty exit increase from 0 percent to 40 percent with fiscal policy. The previous story is missing in a cross-section fiscal incidence analysis.

The above example shows how going beyond the standard cross-section fiscal incidence analysis may give some additional and useful insights to help build a more refined, welfare-oriented fiscal policy. For instance, taking advantage of the availability of longitudinal data on the

\(^3\) Following Blauch and Hoddinott (2000), someone who is “chronic poor” is defined as an individual who is poor in years 1 and 2, and someone who is “transient poor” is defined as an individual who is poor during only one year. While individuals who are poor in year 1 and non-poor in year 2 escape poverty (poverty exit), those who are non-poor in year 1 and poor in year 2 enter poverty (poverty entry).
same individuals (or panel data), this paper sets up a framework to answer developmental questions, such as: what is the incidence of fiscal policy on poverty dynamics? and, how does fiscal policy affect individuals’ income mobility?

The following notations are used throughout this article. Let \( x_{\text{pref}} = (x_{\text{pref}}^1, ..., x_{\text{pref}}^n) \) and \( x_{\text{post}} = (x_{\text{post}}^1, ..., x_{\text{post}}^n) \) denote vectors of prefiscal and postfiscal (respectively) incomes in an initial year, \( t_1 \), and let \( y_{\text{pref}} = (y_{\text{pref}}^1, ..., y_{\text{pref}}^n) \) and \( y_{\text{post}} = (y_{\text{post}}^1, ..., y_{\text{post}}^n) \) denote a vector of prefiscal and postfiscal (respectively) incomes in the subsequent year, \( t_2 \). The same individuals are observed in the two years, as in the typical example of panel data. The distributional change or income mobility is related to the transformation \( x \rightarrow y \), no matter what \( x \) and \( y \) are, either prefiscal or postfiscal incomes. Likewise, the fiscal incidence is summarized by the transformations \( x_{\text{pref}} \rightarrow x_{\text{post}} \) and \( y_{\text{pref}} \rightarrow y_{\text{post}} \) for \( t_1 \) and \( t_2 \).

Let us consider an economy, \( E_{\text{pref}} \), with no fiscal system. In that situation, the incomes of individuals will be given by \( x_{\text{pref}} \) and \( y_{\text{pref}} \) for \( t_1 \) and \( t_2 \). In addition, the transformation \( x_{\text{pref}} \rightarrow y_{\text{pref}} \) will be the resulting distributional change. It is therefore possible to analyze poverty dynamics, as well as income mobility, in \( E_{\text{pref}} \) between \( t_1 \) and \( t_2 \). For example, if the poverty lines are given by \( z_1 \) and \( z_2 \), respectively, in \( t_1 \) and \( t_2 \), then the standard chronic poverty, poverty exit and poverty entry indictors, as defined by Baulch and Hoddinott (2000), will be given respectively by the following:

\[
\begin{align*}
    p_{\text{chronic}}^{\text{pref}}(x_{\text{pref}}, y_{\text{pref}}, z_1, z_2) &= \frac{1}{n} \sum_{i=1}^{n} \mathbb{1}_{\{x_{\text{pref}}^i < z_1\}} \cap \{y_{\text{pref}}^i < z_2\}, \\
    p_{\text{exit}}^{\text{pref}}(x_{\text{pref}}, y_{\text{pref}}, z_1, z_2) &= \frac{1}{n} \sum_{i=1}^{n} \mathbb{1}_{\{x_{\text{pref}}^i < z_1\}} \cap \{y_{\text{pref}}^i > z_2\} \text{ and} \\
    p_{\text{entry}}^{\text{pref}}(x_{\text{pref}}, y_{\text{pref}}, z_1, z_2) &= \frac{1}{n} \sum_{i=1}^{n} \mathbb{1}_{\{x_{\text{pref}}^i > z_1\}} \cap \{y_{\text{pref}}^i < z_2\}. 
\end{align*}
\]
Likewise, regarding the directional income mobility concept, the mean income change in $E_{pref}$ between $t_1$ and $t_2$, as defined by Fields and Ok (1996), is given by the quantity below

$$m_{pref}^n(x_{pref}, y_{pref}) = \frac{1}{n} \sum_{i=1}^{n} (x_{pref}^i - y_{pref}^i).$$

Let us now consider another economy, $E_{post}$, with a fiscal system, $F$, where the incomes of individuals are given by $x_{post}$ and $y_{post}$ in $t_1$ and $t_2$. The existence of $F$ is the only difference between the two economies, $E_{pref}$ and $E_{post}$, all other things being equal. In the same way as above, it is possible to analyze poverty dynamics and income mobility in $E_{post}$. For instance, the three indicators below inform respectively on chronic poverty, poverty exit and poverty entry in $E_{post}$:

$$p_{chronic}^{post}(x_{post}, y_{post}, z_1, z_2) = \frac{1}{n} \sum_{i=1}^{n} \mathbb{I}\{x_{post}^i < z_1\} \cap \{y_{post}^i < z_2\},$$

$$p_{exit}^{post}(x_{post}, y_{post}, z_1, z_2) = \frac{1}{n} \sum_{i=1}^{n} \mathbb{I}\{x_{post}^i < z_1\} \cap \{y_{post}^i > z_2\} \quad \text{and}$$

$$p_{entry}^{post}(x_{post}, y_{post}, z_1, z_2) = \frac{1}{n} \sum_{i=1}^{n} \mathbb{I}\{x_{post}^i > z_1\} \cap \{y_{post}^i < z_2\}.$$

And the mean income change between $t_1$ and $t_2$ in $E_{post}$ is given by

$$m_{post}^n(x_{post}, y_{post}) = \frac{1}{n} \sum_{i=1}^{n} (x_{post}^i - y_{post}^i).$$

The reasoning behind the analysis of fiscal policy’s impact on poverty dynamics and income mobility is to consider an economy without a fiscal system, $E_{pref}$, and determine the distributional change $x_{pref} \rightarrow y_{pref}$ (summarized by indicators of poverty dynamics or income mobility) and compare it to the distributional change $x_{post} \rightarrow y_{post}$ of the “same” economy, $E_{post}$, where the only change is the existence of the fiscal system, $F$, while all other things are kept constant. In other words, as the only change between the two economies, $E_{pref}$ and $E_{post}$, is the operation of the fiscal system, $F$, then the difference between the two distributional changes,
$x_{\text{pref}} \to y_{\text{pref}}$ and $x_{\text{post}} \to y_{\text{post}}$, can be attributed to that fiscal system. The following indicators are therefore useful to evaluate the effect of fiscal policy on poverty dynamics and income mobility:

\[
FPC(x_{\text{pref}}, y_{\text{pref}}, x_{\text{post}}, y_{\text{post}}, z_1, z_2) = \frac{\text{chronic}_\text{post}}{\text{chronic}_\text{pref}}(x_{\text{post}}, y_{\text{post}}, z_1, z_2) - \\
\frac{\text{chronic}_\text{pref}}{\text{chronic}_\text{pref}}(x_{\text{pref}}, y_{\text{pref}}, z_1, z_2),
\]

\[
FPEN(x_{\text{pref}}, y_{\text{pref}}, x_{\text{post}}, y_{\text{post}}, z_1, z_2) = \frac{\text{entry}_\text{post}}{\text{entry}_\text{pref}}(x_{\text{post}}, y_{\text{post}}, z_1, z_2) - \\
\frac{\text{entry}_\text{pref}}{\text{entry}_\text{pref}}(x_{\text{pref}}, y_{\text{pref}}, z_1, z_2),
\]

\[
FPEX(x_{\text{pref}}, y_{\text{pref}}, x_{\text{post}}, y_{\text{post}}, z_1, z_2) = \frac{\text{exit}_\text{post}}{\text{exit}_\text{pref}}(x_{\text{post}}, y_{\text{post}}, z_1, z_2) - \\
\frac{\text{exit}_\text{pref}}{\text{exit}_\text{pref}}(x_{\text{pref}}, y_{\text{pref}}, z_1, z_2)
\]

and

\[
FDM(x_{\text{pref}}, y_{\text{pref}}, x_{\text{post}}, y_{\text{post}}) = \frac{\text{directional}_\text{post}}{\text{directional}_\text{pref}}(x_{\text{post}}, y_{\text{post}}) - \\
\frac{\text{directional}_\text{pref}}{\text{directional}_\text{pref}}(x_{\text{pref}}, y_{\text{pref}}).
\]

The above indicators stand, respectively, for fiscal policy impact on chronic poverty, fiscal policy impact on poverty entry, fiscal policy impact on poverty exit and fiscal policy impact on directional income mobility.

**Definition 1:**

(i) A fiscal system is chronic poverty increasing (decreasing) if, and only if, $FPC > 0$ ($FPC < 0$). When $FPC = 0$, the fiscal system has a neutral effect on chronic poverty.

(ii) A fiscal system is poverty entry increasing (decreasing) if, and only if, $FPEN > 0$ ($FPEN < 0$). When $FPEN = 0$, the fiscal system has a neutral effect on poverty entry.

(iii) A fiscal system is poverty exit increasing (decreasing) if, and only if, $FPEX > 0$ ($FPEX < 0$). When $FPEX = 0$, the fiscal system has a neutral effect on poverty entry.

(iv) A fiscal system is directional mobility increasing (decreasing) if, and only if, $FDM > 0$ ($FDM < 0$). When $FDM = 0$, the fiscal system has a neutral effect on poverty entry.
Given the above definition, one fundamental step in the dynamic analysis of fiscal policy impact is to determine the poverty dynamics and income mobility indicators for both $E_{pref}$ and $E_{post}$, in order to be able to calculate the indices of the definition afterward. However, how are $E_{pref}$ and $E_{post}$ determined in practice?

In practice, one state of nature is known, either $E_{pref}$ or $E_{post}$, and the other is determined following the fiscal incidence analysis for each single year. There is a wide body of literature on the determination of prefiscal and postfiscal incomes. The approaches used in the literature include reduced form regression analyses, microsimulation models, computable general equilibrium models and a combination of computable general equilibrium and microsimulation models and the CEQ institute methodology (Essama-Nssah, 2008; Lustig, 2016). Once the prefiscal and postfiscal incomes are determined for the period of interest, the next step is to calculate poverty dynamics and income mobility indicators considering the prefiscal incomes and then the postfiscal incomes separately. The final step is to compare the distributional changes via the indicators defined above and conclude accordingly following Definition 1.

While the indicators in Definition 1 are useful for evaluating the overall effects of fiscal policy on (directional) income mobility and poverty dynamics, they fail to capture the proportion of individuals having their welfare dynamics negatively or positively impacted by the fiscal system. To address that limitation, we present below two indicators that can be used to evaluate the proportions of individuals falling into chronic poverty and those escaping chronic poverty as a result of the operation of the fiscal system$^4$.

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$^4$ Similar indicators have been proposed for cross sectional analysis in Higgins and Lustig (2016) to determine the poor subpopulation who pay more in taxes than they receive in transfers and the
**Definition 2:**

(i) An individual is chronically impoverished by fiscal policy if he or she becomes chronically poor following the operation of the fiscal system.

(ii) An individual fiscally escapes chronic poverty if he or she becomes transient poor or nonpoor due to fiscal policy.

Equivalently, **Definition 2-(i)** means that, to be chronically impoverished by a fiscal system, an individual must meet the two following conditions: (a) he or she is chronic poor after the implementation of the fiscal system, and (b) he or she is not chronic poor before the fiscal system is put in place. **Definition 2-(ii)** identifies a chronically poor individual before the fiscal policy who becomes transient poor or nonpoor (for the 2 years) after the fiscal policy. Consequently, an individual who escapes chronic poverty due to fiscal policy meets these two conditions: (a) he or she is chronically poor before the implementation of the fiscal system, and (b) he or she is not chronically poor after the fiscal system is put in place.

**Lemma 1:**

(i) An individual is chronically impoverished by fiscal policy if, and only if, his or her income meets the following condition:

\[
A = \left(\left(\{x_{pref} < z_1\} \cap \{y_{pref} > z_2\}\right) \cup \left(\{x_{pref} > z_1\} \cap \{y_{pref} < z_2\}\right)\right) \\
\cup \left(\{x_{pref} > z_1\} \cap \{y_{pref} > z_2\}\right) \cap \left(\{x_{post} < z_1\} \cap \{y_{post} < z_2\}\right)
\]

(ii) A chronically poor individual has received a positive gain from the fiscal policy if, and only if, his or her income satisfies the following condition:

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poor subpopulation who pay less in taxes than they receive in transfers. The authors define the former as Fiscal Impoverishment and the latter as Fiscal Gain to the poor.
\[ B = \left( \{ x_{\text{post}} < z_1 \} \cap \{ y_{\text{post}} > z_2 \} \right) \cup \left( \{ x_{\text{post}} > z_1 \} \cap \{ y_{\text{post}} < z_2 \} \right) \]
\[ \cup \left( \{ x_{\text{post}} > z_1 \} \cap \{ y_{\text{post}} > z_2 \} \right) \cap \left( \{ x_{\text{pref}} < z_1 \} \cap \{ y_{\text{pref}} < z_2 \} \right) \]

The positive gain\(^5\) from fiscal policy considered here is a gain that is large enough to make an individual who is chronically poor before the intervention of the fiscal system escape chronic poverty after the intervention of the fiscal system.

Proof: The proof of Lemma 1 is straightforward.

(i) Given Definition 2-(i), the above two conditions can be rewritten as follows:

Condition 1, an individual \( i \in [1, n] \) being chronically impoverished by fiscal policy means that \( x_{\text{post}}^i < z_1 \) and \( y_{\text{post}}^i < z_2 \) or equivalently that \( i \in A_4 = \{ x_{\text{post}} < z_1 \} \cap \{ y_{\text{post}} < z_2 \} \)

Condition 2, an individual \( i \in [1, n] \) being chronically impoverished by fiscal policy means that, for at least one year, his or her prefiscal income does not fall below the poverty line. That is, \( x_{\text{pref}}^i > z_1 \) and \( y_{\text{pref}}^i > z_2 \), or \( x_{\text{pref}}^i < z_1 \) and \( y_{\text{pref}}^i > z_2 \), or \( x_{\text{pref}}^i > z_1 \) and \( y_{\text{pref}}^i < z_2 \). Equivalently, \( i \in A_1 \cup A_2 \cup A_3 \) where \( A_1 = \{ x_{\text{pref}} > z_1 \} \cap \{ y_{\text{pref}} > z_2 \} \), \( A_2 = \{ x_{\text{pref}} < z_1 \} \cap \{ y_{\text{pref}} > z_2 \} \) and \( A_3 = \{ x_{\text{pref}} > z_1 \} \cap \{ y_{\text{pref}} < z_2 \} \).

The two conditions taken together prove Lemma 1-(i).

(ii) Regarding Definition 2-(ii), the two conditions can be rewritten as follows:

Condition 1, a chronically poor individual \( i \in [1, m] \) receiving a positive gain from fiscal policy means that \( x_{\text{pref}}^i < z_1 \) and \( y_{\text{pref}}^i < z_2 \) or, equivalently, that \( i \in B_4 = \{ x_{\text{pref}} < z_1 \} \cap \{ y_{\text{pref}} < z_2 \} \)

\(^5\) It is possible to have a positive gain in the sense that postfiscal income is greater than prefiscal income, but the gain is not big enough to make a chronically poor individual escape chronic poverty after the intervention of the fiscal system.
Condition 2, a chronically poor individual \( i \in [1, m] \) receiving a positive gain from fiscal policy means that, for at least one year, his or her postfiscal income does not fall below the poverty line. That is, \( x_{post}^i > z_1 \) and \( y_{post}^i > z_2 \), or \( x_{post}^i < z_1 \) and \( y_{post}^i > z_2 \), or \( x_{post}^i > z_1 \) and \( y_{post}^i < z_2 \). Equivalently, \( i \in B_1 \cup B_2 \cup B_3 \) where \( B_1 = \{x_{post}^i > z_1\} \cap \{y_{post}^i > z_2\} \), \( B_2 = \{x_{post}^i < z_1\} \cap \{y_{post}^i > z_2\} \) and \( B_3 = \{x_{post}^i > z_1\} \cap \{y_{post}^i < z_2\} \).

The two conditions taken together prove Lemma 1-(ii).

Theorem 1:

(i) The proportion of individuals who are chronically impoverished by fiscal policy is given by the following indicator of fiscal chronic impoverishment:

\[
FCI(x_{pref}, y_{pref}, x_{post}, y_{post}, z_1, z_2) = \frac{1}{n} \sum_{i=1}^{n} \mathbb{I}([x_{pref}^i > z_1] \cap [y_{pref}^i > z_2]) \cup ([x_{pref}^i < z_1] \cap [y_{pref}^i > z_2]) \cup ([x_{pref}^i > z_1] \cap [y_{pref}^i < z_2]) \cap ([x_{post}^i < z_1] \cap [y_{post}^i < z_2])
\]

(ii) The proportion of chronically poor individuals receiving a positive gain from fiscal policy is given by the fiscal gain to chronically poor indicator below:

\[
FGC(x_{pref}, y_{pref}, x_{post}, y_{post}, z_1, z_2) = \frac{1}{m} \sum_{i=1}^{m} \mathbb{I}([x_{post}^i > z_1] \cap [y_{post}^i > z_2]) \cup ([x_{post}^i < z_1] \cap [y_{post}^i > z_2]) \cup ([x_{post}^i > z_1] \cap [y_{post}^i < z_2]) \cap ([x_{pref}^i < z_1] \cap [y_{pref}^i < z_2])
\]

Proof: The proof of Theorem 1 comes directly from Lemma 1.

The two proposed indicators have two desirable properties, namely, subgroup decomposability and scale invariance.

Proposition 1 (Subgroup Decomposability): Partition the population into \( J \in \{1, \ldots, N\} \) subgroups
and let \( n_j \) and \( m_j \) stand for the number of persons in subgroup \( j \). For any \( j = 1, ..., J \) and 
\[
x_{pref}^j, x_{post}^j, y_{pref}^j, y_{post}^j, z_1, z_2 \in R_+,
\]

\[
FCI(x_{pref}, y_{pref}, x_{post}, y_{post}, z_1, z_2) = \sum_{j=1}^J \left( \frac{n_j}{n} \right) FCI_j(x_{pref}^j, y_{pref}^j, x_{post}^j, y_{post}^j, z_1, z_2)
\]

\[
FGC(x_{pref}, y_{pref}, x_{post}, y_{post}, z_1, z_2) = \sum_{j=1}^J \left( \frac{m_j}{m} \right) FGC_j(x_{pref}^j, y_{pref}^j, x_{post}^j, y_{post}^j, z_1, z_2)
\]

**Proof:** Appendix B

Subgroup decomposability is a very useful property for empirical applications. For instance, while it is important to know the extent of chronic fiscal impoverishment for the whole country, knowing the contribution of each socioeconomic group is extremely useful for the design of targeted policies.

**Proposition 2 (scale invariance):** For all \( x_{pref}^j, x_{post}^j, y_{pref}^j, y_{post}^j, z_1, z_2 \in R_+ \), and \( \gamma > 0 \)

\[
FCI(\gamma x_{pref}, \gamma y_{pref}, \gamma x_{post}, \gamma y_{post}, \gamma z_1, \gamma z_2) = FCI(x_{post}, y_{post}, x_{pref}, y_{pref}, z_2, z_1)
\]

\[
FGC(\gamma x_{pref}, \gamma y_{pref}, \gamma x_{post}, \gamma y_{post}, \gamma z_1, \gamma z_2) = FGC(x_{post}, y_{post}, x_{pref}, y_{pref}, z_2, z_1)
\]

**Proof:** Appendix B

The property of scale invariance means that the indicators are invariant to changes in scale. For example, if the income of each individual is doubled during the two years, as well as the poverty lines, the value of the indicators will remain unchanged.

This section has set up a framework that enables the evaluation of the effects of a given fiscal system on welfare dynamics. Let us turn now to a real-world application of the defined measures in the next section.
3 Empirical application: impact of fiscal policy on poverty dynamics and income mobility in Niger between 2011 and 2014

To illustrate how the analysis of fiscal policy impact on income dynamics can be applied, the case of Niger between 2011 and 2014 is considered, where the chosen fiscal incidence methodology is the CEQ institute framework (see Lustig, 2016 for more details about the CEQ methodology).

3.1 Data

This study used both micro- and macrodata. The microdata come from the panel National Survey on Household Living Conditions and Agriculture (in French *Enquête nationale sur les Conditions de Vie des Ménages et Agriculture* or ECVM/A), and the macrodata are the state budget and national accounts data (which are required for the chosen fiscal incidence method).

ECVMA is a survey analogous to the Living Standards Measurement Study-Integrated Survey on Agriculture (LSMS-ISA), a program of the World Bank Group designed to collect nationally representative data at the household and individual levels on a variety of social indicators, such as consumption and agriculture. LSMS-ISA is a panel survey conducted every three years. The first and second waves of the panel survey were implemented in Niger in 2011 and 2014 with national coverage, including both urban and rural areas in all regions of the country.

The sample of ECVMA 2011 was chosen through a random two stages process. In the first stage, some number of Enumeration Areas (EA) were selected with Probability Proportional to Size (PPS), using the 2001 General Census of Population and Housing as the base for the sample. In the second stage, 12 or 18 households were selected with equal probability in each urban or rural EA, respectively. The total estimated size of the 2011 sample was 4,074 households, which takes into account the possibility of losing some households between the two surveys with minimal
adverse effects on the analyses. In the ECVM/A 2014, all the interviewed households in 2011 were tracked. Households, as well as individuals who moved to a new location, were followed and interviewed in their new location. However, those who removed of the country were not interviewed. Finally, the total size of the panel is 3,433 households matching between the two waves. Expansion factors or weights have been recalculated in order to produce nationally representative statistics with the data.

The state budget and national accounts data come from Niger’s BOOST and the Statistics Book of Niger’s National Institute of Statistics. Executed government social spending in education and health come from the former, which is a World Bank Group project to enhance budget analysis across the globe by improving access to government expenditure data and linking spending to outputs and outcomes to the extent of possibilities. Data on public taxes comes from the latter.

3.2 CEQ methodology

The general objective of the CEQ methodology is to assess the impact of a state’s fiscal policy and its public spending on household welfare. The method seeks to identify households that bear the burden of taxes and those that benefit from state social spending. The method uses two types of data: macrodata from the state budget and national accounts and microdata coming from household surveys. Eligible households are allocated the amount of social spending they have received and the taxes they have paid, using institutional criteria and household survey data. When information is not available from a household survey, information from other sources may be used. The analysis uses various income concepts to measure the implications of each fiscal intervention. The different income concepts are defined similarly in 2011 and 2014, as the structure of Niger’s fiscal system was similar between the two years.
Market income is the prefiscal income, or individuals’ income before any fiscal intervention. It includes gross income from labor and capital, self-production and private transfers. Net market income is constructed by deducting direct taxes from market income. The direct taxes included here are taxes on salaries and wages. Disposable income is obtained by adding direct transfers to net market income. Household consumption from the microdata is assumed here to be equal to disposable income. That assumption is often used in low-income economies where data on consumption are more reliable than data on income and savings. Other income concepts are calculated using a backward and forward approach. The direct transfers considered are scholarships and support to nongrant students, and school feeding programs. The beneficiary households are directly identified in the microdata for the former, and they are randomly selected on the basis of the rules and the geographical areas covered by the program for the latter.

When indirect subsidies are added to disposable income, and indirect taxes are deducted, the result is consumable income or postfiscal income, i.e., household income after the various fiscal interventions. Agricultural subsidies are the only type of indirect subsidies considered. Indirect taxes include VATs, import taxes and other indirect taxes. Given the importance of the informal sector in Niger (informality contributes approximately 70 percent of the GDP according to the National Institute of Statistics), the risk of tax evasion is high. The rates used for the various indirect taxes are therefore effective rates calculated based on the Niger 2012 Social Accounting Matrix (SAM), rather than the statutory rates. Moreover, in addition to the direct effects of indirect taxes, indirect effects are included using the input-output matrix from the 2012 SAM. The overall effect of indirect taxes on household welfare is therefore equal to the sum of the direct effect and the indirect effect, and this is calculated following the Paasche variation by assuming price-inelastic demand. As the objective of this analysis is to evaluate the effects of fiscal policy on
poverty (dynamics), consumable income is the final income concept here, although it is possible to go beyond that income concept by computing the “final income”, which is obtained by adding the monetized value of public education and health services net of payments made by households to benefit from those services. Further details about the methods of allocation of each fiscal item considered here can be found in Appendix C.

Once all the income concepts are defined, the framework presented in Section 2 can easily be applied considering market income as the prefiscal income and consumable income as the postfiscal income to determine the impact of Niger’s fiscal system on poverty dynamics and income mobility.

3.3 Results and discussions

3.3.1 Fiscal policy impact on poverty dynamics

Figure 1 reports Niger’s chronic poverty, poverty entry and poverty exit ratios by three income concepts at the national level and the area of residence level. It shows that, while fiscal policy contributes to the decrease of poverty entry in the country, it increases chronic poverty and poverty exit. The same directional effect in the whole country is also observed in urban and rural areas.
Poverty is mostly a chronic phenomenon in Niger. More than a half of the poor in 2011 remain poor in 2014, regardless of the income concept considered. A total of 58.8 percent and 60.9 percent of the poor in the starting year are also poor in the ending year based on prefiscal income and postfiscal income, respectively. It turns out that the fiscal system has an increasing effect on the chance of being chronically poor in the country. The probability of a poor individual in 2011 experiencing chronic poverty increases by more than 2 percentage points in the presence of the fiscal system in place over the period of 2011-2014.

**Figure 1.** Impact of fiscal policy on poverty dynamics (%) in Niger, 2011-2014.
Chronic poverty rises by more than 3 percentage points with fiscal policy in Niger, with an FPC indicator of 3.18 percent. Although direct taxes and direct transfers do not negatively impact chronic poverty in the country, it increases from 28.67 percent to 31.85 percent because of the negative effect of the indirect interventions of the fiscal system. The directional impact is the same in the two areas of residence. However, the (negative) effect of the indirect interventions of the fiscal system is five times higher in rural areas. Indeed, the FPC indicator in urban areas is 0.63 percent, while in rural areas it is equal to 3.66 percent (Table 2). Therefore, reducing chronic poverty in the country requires a reform of indirect taxes focusing on lessening their effect on rural areas especially. Although approximately 8 out of 10 people live in rural areas, that zone is the most affected by chronic poverty regardless of income concepts.

**Table 2.** Indicators of fiscal policy impact on poverty dynamics in Niger (%), 2011-2014.

<table>
<thead>
<tr>
<th>From Market income to Disposable income</th>
<th>FPC</th>
<th>FPEN</th>
<th>FPEX</th>
</tr>
</thead>
<tbody>
<tr>
<td>All population</td>
<td>-0.05</td>
<td>-0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>-0.07</td>
<td>-0.11</td>
<td>-0.03</td>
</tr>
<tr>
<td>Rural</td>
<td>-0.06</td>
<td>-0.01</td>
<td>0.06</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>From Market income to Consumable income</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>All population</td>
<td>3.18</td>
<td>-0.7</td>
<td>0.49</td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>0.63</td>
<td>-0.14</td>
<td>1.29</td>
</tr>
<tr>
<td>Rural</td>
<td>3.66</td>
<td>-0.8</td>
<td>0.34</td>
</tr>
</tbody>
</table>

Source: The authors

Regarding fiscal policy impact on transient poverty, Table 2 reveals that the change in poverty exit and poverty entry is below one percentage point. The FPEN and FPEX indicators equal -0.03 percent and 0.04 percent, respectively, meaning that poverty entry decreases by 0.03 percentage points, while poverty exit increases by 0.04 percentage points with fiscal policy. It
turns out that, compared to chronic poverty, transient poverty is less sensitive to the fiscal system in Niger.

3.3.2 Fiscal chronic impoverishment and fiscal gain of the chronically poor

Table 3 summarizes the indicators of the fiscal chronic impoverishment and the fiscal gain to the chronically poor in Niger and in the areas of residence. It indicates that the combined effect of direct taxes and direct transfers on chronic impoverishment is neutral. In other words, neither prefiscal transient poor, nor prefiscal chronically non poor are pushed into chronic poverty due to the direct effect of the fiscal system.

Table 3. Indicators of FCI and FGC in Niger, 2011-2014.

<table>
<thead>
<tr>
<th>From Market income to Disposable income</th>
<th>Population share (%)</th>
<th>FCI (%)</th>
<th>FGC (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>index contribution to national level</td>
<td>index contribution to national level</td>
<td></td>
</tr>
<tr>
<td>All population</td>
<td>100</td>
<td>0</td>
<td>-</td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>16.24</td>
<td>0</td>
<td>0.07</td>
</tr>
<tr>
<td>Rural</td>
<td>83.76</td>
<td>0</td>
<td>0.05</td>
</tr>
<tr>
<td>From Market income to Consumable income</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>All population</td>
<td>100</td>
<td>3.28</td>
<td>0.11</td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>16.24</td>
<td>0.63</td>
<td>0.102</td>
</tr>
<tr>
<td>Rural</td>
<td>83.76</td>
<td>3.79</td>
<td>3.175</td>
</tr>
</tbody>
</table>

Source: The authors

However, the FCI indicator equals 3.28 percent, indicating that more than 3 percent of the population become chronically poor because of the indirect interventions of fiscal policy. Regarding the area of residence, while less than 1 percent become chronically poor in urban areas, 3.7 percent of the population living in rural areas fall into chronic poverty because of indirect taxes. It turns out that, compared to rural areas, in urban areas, individuals are less sensitive to the chronic impoverishment effect of indirect taxes. Taking advantage of the decomposability of the FCI
indicator, the aggregate chronic impoverishment is decomposed for each area of residence in Table 3. It is found that approximately 97 percent of the chronically impoverished population in the presence of fiscal policy live in rural areas.

Regarding the FGC indicator, the results indicate that only very few individuals escape chronic poverty due to fiscal interventions in Niger. The indicator equals 0.06 percent and 0.13 percent, respectively, from market income to disposable income, and from market income to consumable income. Decomposing the FGC indicator by area of residence reveals that most of those who escape chronic poverty thanks to fiscal policy live in rural areas, approximately 80 percent and 100 percent from market income to disposable income and from market income to consumable income, respectively.

3.3.3 Fiscal policy impact on directional income mobility

The analysis of fiscal policy’s effects on directional income mobility reveals that the mean per capita income gain between 2011 and 2014 decreases in Niger in the presence of the fiscal system. The loss in income gain due to fiscal interventions is also observed in urban and rural areas. All incomes are measured in real terms to consider the aggregate income movements as the result of real income movements of individuals, as suggested by Fields and Ok (1999). The incomes in 2014 have been deflated\(^6\), taking year 2011 as the baseline. In doing so, all movements occurring between the two years are corrected from the effect of inflation.

Income mobility is geographically disparate in Niger, regardless of the fiscal system. Income grows faster in urban areas. The mean per capita income gain in urban areas is

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\(^6\) The ratio of the poverty line in 2014 to the poverty line in 2011 is the deflator.
approximately 3 times higher than the mean per capita income gain in the whole country, and approximately 5 times higher than that in rural areas considering any income concept (Figure 2).

![Figure 2](image-url)

**Source:** The authors

**Figure 2.** Impact of fiscal policy on per capita directional income mobility (CFA francs) in Niger, 2011-2014.

Although the direct interventions of the fiscal system do not hurt poverty dynamics, they contribute to the decrease in directional income mobility. From 14,592 CFA francs, the mean per capita income gain falls to 13,470 CFA francs with direct taxes and direct subsidies at the country level. The same directional effect is observed in the two areas of residence. Income gain drops from 47,623 CFA francs and 8,187 CFA francs to 40,949 CFA francs and 8,141 CFA francs in urban and rural areas, respectively.

In urban areas, direct taxes and direct subsidies have a higher negative effect on income gain than indirect taxes and indirect subsidies, while it is the opposite in rural areas. In urban areas,
the FDM indicator equals 6,673.08 CFA francs and 9,701.31 CFA francs from market income to disposable income and from market income to consumable income, respectively, while the FDM indicator in rural areas is respectively equal to 45 CFA francs and 363.81 CFA francs (Table 4). Niger’s fiscal system decreases income gain more rapidly in urban areas than in rural areas, and the share (impact) of each intervention, direct or indirect, of the system is divergent in the two areas. In urban areas, 68 percent of the decrease in income gain comes from the effect of direct taxes and direct transfers, compared to 60 percent and 12 percent for Niger as a whole and rural areas, respectively.

Table 4. Indicator of fiscal policy impact on directional income mobility in Niger, 2011-2014.

<table>
<thead>
<tr>
<th>From Market income to Disposable income</th>
<th>FDM (absolute change in CFA franc)</th>
<th>FDM (percentage change in %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All population</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>(6,674.08)</td>
<td>-14.01</td>
</tr>
<tr>
<td>Rural</td>
<td>(45.00)</td>
<td>-0.55</td>
</tr>
<tr>
<td>From Market income to Consumable income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>All population</td>
<td>(1,880.50)</td>
<td>-12.89</td>
</tr>
<tr>
<td>Area of residence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Urban</td>
<td>(9,701.31)</td>
<td>-20.37</td>
</tr>
<tr>
<td>Rural</td>
<td>(363.81)</td>
<td>-4.44</td>
</tr>
</tbody>
</table>

Source: The authors

4 Conclusion

The main focus of this paper was to assess the impact of fiscal policy on welfare dynamics. It is shown how the impact of a given fiscal system on poverty dynamics and income mobility can be analyzed within a comprehensive framework. An empirical application to Niger illustrates the usefulness of the proposed methodology.
The results show that the overall effects of fiscal policy on welfare dynamics are negative in Niger between 2011 and 2014. The fiscal system increases chronic poverty by 3.18 percentage points and results in pushing 3.28 percent of the population into chronic poverty, although direct taxes and direct transfers are almost neutral. These findings indicate that various indirect taxes are the source of the negative impact of fiscal policy on chronic poverty in Niger. Regarding directional income mobility, the effects of indirect taxes on per capita income gain are, however, limited compared to the effects of direct taxes. In fact, three fifths of the decrease in income gain is due to the direct interventions of the fiscal system.

This analysis can be extended in Three ways. First, this paper focuses on the poverty dynamic concepts defined by Baulch and Hoddinott (2000). A similar approach can easily be developed to consider different poverty dynamic concepts, such as those defined by Morduch (1994) or Jalan and Ravallion (1998). The former defines the notions of the stochastic poor, i.e., individuals who have a current income below the poverty line, but not a permanent income, and the structural poor, i.e., individuals who are poor following a change in their structural characteristics, such as new births that increase the size of the household in which the individual is living, and the latter defines the chronic poor as individuals who have mean consumption over time below the poverty line, while not being poor at all times. Second, the attention of the current work is restricted to the short run. Understanding the link between fiscal policy and poverty duration (a long run analysis), for example, may be beneficial to building a strong fiscal system that is favorable to effective poverty alleviation. Last but not least, the prefiscal and postfiscal incomes are determined in this paper following the CEQ institute methodology. While it allows one to paint a complete picture of a fiscal system (including both taxation and social spending), the CEQ methodology does not incorporate behavioral or general equilibrium effects. Therefore,
determining the prefiscal and postfiscal incomes following a methodology that incorporates behavioral responses, such as the computable general equilibrium model, can overcome that limitation.

Acknowledgements

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Declarations of interest

None
Appendix A. Income mobility concepts

The indicators presented here come from Fields (2005).

*Time-dependence*

One way to analyze the time-dependence mobility is to calculate the correlation between the income distributions at the start and subsequent years. The idea is that if well-being in the past perfectly determines well-being in the present, the two well-being should be strongly linked. The Pearson correlation coefficient and the Spearman rank correlation coefficient are some examples of indicators that may be used to evaluate time-dependence income mobility in case the micro-data on individuals are available. The interpretation for the two preceding indicators is that the more positive and higher the correlation is, the more immobility appears in the data and conversely. Other indicators are the gamma, the Kendall’s tau-b which are used when the quantile transition matrix is constructed.

*Positional movement*

The positional movement has been assessed by many researchers through the immobility ratio, the fraction of population lying along the diagonal of a quantile (quintile, decile, …) transition matrix. If there is perfect immobility, the transition matrix will be the identity matrix. Additional indicators used in the literature are the absolute mean number of quantiles moved, the mean upward jump, etc.

*Share movement*

One measure of share movement which is commonly calculated is the inverse of the correlation coefficient frequently calculated from micro data. Because the correlation between base year and final year incomes is the same as the correlation between base-year and final-year income shares.
**Income flux**

One measure of income flux is the first Fields-Ok (1999) per capita index \( m^{(1)}_n(x,y) = \frac{1}{n} \sum_{j=1}^{n} |x_i - y_i| \) capturing the mean absolute income change where \( n, x_i \) and \( y_i \) stand respectively for the population number, the income of individual \( i \) in base-year and the income of the same individual \( i \) in the final-year. That measure treats income loss and income gain the same way. One additional measure is the second Fields-Ok (1999) per capita index \( m^{(2)}_n(x,y) = \frac{1}{n} \sum_{j=1}^{n} |\log(x_i) - \log(y_i)| \) which gives less value to the change of the highest incomes than the lowest ones.

**Directional income movement**

Fields and Ok (1999b) proposed an axiomatized measure of directional income movement \( m^{(3)}_n(x,y) = \frac{1}{n} \sum_{j=1}^{n} (\log x_i - \log y_i) \) which combines gains and losses of income as well as the income levels of each of the gainers and each of the losers.

**Mobility as an equalizer of longer-term incomes relative to the base year**

That mobility concept can be analyzed with the equalization measure \( \epsilon = 1 - \left( \frac{I(\alpha)}{I(K)} \right) \)

where \( \alpha \) is the vector of averages incomes, \( K \) is the vector of the base-year income and \( I(\cdot) \) is an inequality measure (Gini or Theil indices for example). \( \epsilon = 0 \) means that incomes over a long period are distributed as unequally as base-year incomes are, \( \epsilon > 0 \) describes a situation where income mobility causes longer term incomes to be more equally distributed than were base-year incomes and conversely.
Appendix B. Proof of propositions 1 and 2

Proposition 1: Subgroup decomposability

Let define $\Omega$ as the universe of all the collections of population. $\Omega_1$ and $\Omega_2$ are respectively the sub-universes of all the collections of population defined in lemma 1-(i) and lemma 1-(ii) respectively.

$A$ is the total population of lemma 1-(i), and $A_1, \ldots, A_J$ are $J$ partitions of population $A$. Thus,

$$A = \bigcup_{j=1}^{J} A_j$$

And $\text{card}(A) = n$, for any $j = 1, \ldots, J$, $\text{card}(A_j) = n_j$. $A \in \Omega_1$ and for any $j = 1, \ldots, J$, $A_j \in \Omega_1$.

$B$ is the total population of lemma 1-(ii), and $B_1, \ldots, B_J$ are $J$ partitions of population $B$. Thus,

$$B = \bigcup_{j=1}^{J} B_j$$

And $\text{card}(B) = m$, for any $j = 1, \ldots, J$, $\text{card}(B_j) = m_j$. $B \in \Omega_1$ and for any $j = 1, \ldots, J$, $B_j \in \Omega_1$.

$\forall X \in \Omega_1$ and $\forall Y \in \Omega_2$, let define two functions $FCI$ and $FGC$ defined from $\Omega_1$ and $\Omega_2$ (respectively) to $R_+$ such as:

$$FCI(X) = \frac{1}{\text{card}(X)} \sum_{i=1}^{\text{card}(X)} \mathbb{I}_{i \in X}$$

$$FGC(Y) = \frac{1}{\text{card}(Y)} \sum_{i=1}^{\text{card}(Y)} \mathbb{I}_{i \in Y}$$
(i) $FCI(A) = FCI(\cup_{j=1}^j A_j)$

\[
FCI(A) = \frac{1}{n} \sum_{i=1}^n I_{i \in A}
\]

\[
FCI\left(\bigcup_{j=1}^j A_j\right) = \frac{1}{n} \sum_{i=1}^n I_{i \in \cup_{j=1}^j A_j} = \frac{1}{n} \sum_{i=1}^n \sum_{j=1}^j I_{i \in A_j} = \frac{1}{n} \sum_{i=1}^n \frac{n_j}{n} \sum_{j=1}^j I_{i \in A_j} = \frac{n_j}{n} \sum_{j=1}^j \sum_{i=1}^{n_j} I_{i \in A_j}
\]

\[= \frac{n_j}{n} \sum_{j=1}^j FCI(A_j)
\]

Then,

\[
FCI(A) = \frac{n_j}{n} \sum_{j=1}^j FCI(A_j)
\]

(ii) $FGC(B) = FGC(\cup_{j=1}^j B_j)$

\[
FGC(B) = \frac{1}{m} \sum_{i=1}^m I_{i \in B}
\]

\[
FGC\left(\bigcup_{j=1}^j B_j\right) = \frac{1}{m} \sum_{i=1}^m I_{i \in \cup_{j=1}^j B_j} = \frac{1}{m} \sum_{i=1}^m \sum_{j=1}^j I_{i \in B_j} = \frac{1}{m} \sum_{i=1}^m \frac{m_j}{m} \sum_{j=1}^j I_{i \in B_j} = \frac{m_j}{m} \sum_{j=1}^j \sum_{i=1}^{m_j} I_{i \in B_j}
\]

\[= \frac{m_j}{m} \sum_{j=1}^j FGC(B_j)
\]

Then,

\[
FGC(B) = \frac{m_j}{m} \sum_{j=1}^j FGC(B_j)
\]
QED.

Proposition 2: Scale invariance

For all $x_{pref}^j, x_{post}^j, y_{pref}^j, y_{post}^j, z_1, z_2 \in R_+$, and $\gamma > 0$,

(i)

$$FCI(x_{pref}, y_{pref}, x_{post}, y_{post}, z_1, z_2)$$

$$= \frac{1}{n} \sum_{i=1}^{n} \mathbb{I}(\{x_{pref}^{i} > x_1\} \cap \{y_{pref}^{i} > y_2\}) \cup \{\{x_{pref}^{i} < x_1\} \cap \{y_{pref}^{i} > y_2\}\} \cup \{\{x_{pref}^{i} > x_1\} \cap \{y_{post}^{i} > z_2\}\} \cap \{\{x_{post}^{i} < x_1\} \cap \{y_{post}^{i} > z_2\}\}$$

So,

$$FCI(\gamma x_{pref}, y_{pref}, x_{post}, y_{post}, \gamma z_1, \gamma z_2)$$

$$= \frac{1}{n} \sum_{i=1}^{n} \mathbb{I}(\{x_{pref}^{i} > x_1\} \cap \{y_{pref}^{i} > y_2\}) \cup \{\{x_{pref}^{i} < x_1\} \cap \{y_{pref}^{i} > y_2\}\} \cup \{\{x_{pref}^{i} > x_1\} \cap \{y_{pref}^{i} < y_2\}\} \cap \{\{x_{post}^{i} < x_1\} \cap \{y_{post}^{i} < z_2\}\}$$

Then,

$$FCI(\gamma x_{pref}, y_{pref}, x_{post}, y_{post}, \gamma z_1, \gamma z_2) = FCI(x_{pref}, y_{pref}, x_{post}, y_{post}, z_1, z_2)$$

(ii) The proof is similar to (i)

GED.
Appendix C. Methods of allocation and total taxes/social spending included in the analysis

I- Methods of allocation

The CEQ methodology consists in different methods to allocate taxes and social spending from national account to individuals in household survey. The methods include direct identification used when the survey reports the beneficiaries of social spending (the taxpayers) and the amount they received (paid); imputation used when the beneficiaries of spending (the taxpayers) are reported in the survey, but not the amount they receive (paid); simulation used when neither the beneficiaries of spending (the taxpayer) nor the amount they received (paid) is reported in the survey. The allocation method is selected regarding the availability of information in the survey. The allocation methods used in the case of Niger are described below for each item of the fiscal system.

Direct transfers

Scholarships and support to non-grand students in Niger are given to university student meeting the criteria of the Direction des Bourses et des Aides Financières (holding the nationality, having filled an application, …). Thus, the coverage of that program is university students who are citizen in Niger. The beneficiaries of that program as well as the amount they received are reported in the two surveys, thus the allocation method is direct identification.

School feedings, the Government put in place, depending of the area, two types of school feedings (cantines nomades et cantines sédentaires) to improve school attendance and success rate. School feedings’ program covers primary and secondary students mostly located in nomadic and sedentary regions. While the surveys do not directly identify the beneficiaries, they do inform on the education level and the school types of each individual. Besides, the statistical book of the
National Institute of Statistics contains data about the geographical repartition of school feedings. The potential beneficiaries (people attending either primary or secondary education) are identified and the current program repartition is considered through the regional quotas to randomly select the beneficiaries in each region and impute them the per capita cost of the program.

*Direct taxes*

**Wage taxes**, a monthly progressive rate on gross salary, are due by any type of salary employment excepted international organization and family employees. The surveys allow determining the different types of salary employment and the (net) wage received by each employee. The net wages are grossed up and the corresponding taxes paid by employees is simulated based on the prevailing tax brackets and holding the wages fiscal pressure in the surveys (total taxes on wages/total household consumption) to be equal to the wages fiscal pressures in the national account (total taxes on wages/total household consumption).

*Indirect taxes*

**VAT, import duties and other taxes on goods and services** are included through their effective rate derived from Niger’s Social Accounting Matrix (SAM) in 2012 for each category (sector0 of products. The same effective rate is considered in 2011 and 2014, assuming that an indirect tax effective rate cannot significantly change during a short period of time. The consumption level of individual in each products category (SAM classification) is computed in the surveys by matching the surveys products to the SAM categories. Then, the SAM effective rate in each category for the different taxes is applied to the corresponding categories in the surveys to deduct (or impute) the part of the total consumption expenditure falling into indirect taxes (direct effects). Moreover, the input - output matrix is used to determine the indirect effects of each taxes taking into account that non-exempt sectors of VAT only have direct effects.
**Indirect subsidies**

**Subsidies on agriculture**, consisting in agricultural extension services, are provided by the Government to farmers to train them to farming techniques, mechanization, … The surveys have one section on agricultural extension services which allows to directly identify the beneficiaries of the program. Then, the amount of the program total expenditure is divided by the total beneficiaries to determine and impute to each beneficiary the per capita program cost.

II- **Taxes/social spending included in the analysis**

The analysis includes at least 30% of Government total revenue in Niger, which is the equivalent of more than 5% and 6% of the country’s GDP respectively in 2011 and 2014 (Table 5). Regarding the expenditure side, social spending included are about 1% of Government total expenditure in both years (Table 6).

**Table 5. Structure of Government revenue in Niger, 2011-2014**

<table>
<thead>
<tr>
<th></th>
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<tbody>
<tr>
<td>Budget revenue</td>
<td>-</td>
<td>432,485</td>
<td>714,170</td>
<td>79.2%</td>
<td>76.3%</td>
<td>14.3%</td>
<td>17.6%</td>
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<tr>
<td>Taxes</td>
<td>-</td>
<td>403,885</td>
<td>633,170</td>
<td>74.0%</td>
<td>67.6%</td>
<td>13.4%</td>
<td>15.6%</td>
<td>-</td>
</tr>
<tr>
<td>Personal and corporate income taxes</td>
<td>-</td>
<td>96,589</td>
<td>190,791</td>
<td>17.7%</td>
<td>20.4%</td>
<td>3.2%</td>
<td>4.7%</td>
<td>-</td>
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<tr>
<td>Wages and salary taxes</td>
<td>Yes</td>
<td>20,960</td>
<td>41,219</td>
<td>3.8%</td>
<td>4.4%</td>
<td>0.7%</td>
<td>1.0%</td>
<td>Simulation</td>
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<tr>
<td>Corporate taxes</td>
<td>No</td>
<td>62,105</td>
<td>128,719</td>
<td>11.4%</td>
<td>13.7%</td>
<td>2.1%</td>
<td>3.2%</td>
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<tr>
<td>Other direct taxes</td>
<td>No</td>
<td>13,523</td>
<td>20,853</td>
<td>2.5%</td>
<td>2.2%</td>
<td>0.4%</td>
<td>0.5%</td>
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<tr>
<td>Indirect taxes</td>
<td>-</td>
<td>297,696</td>
<td>381,379</td>
<td>54.5%</td>
<td>40.7%</td>
<td>9.8%</td>
<td>9.4%</td>
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<tr>
<td>Taxes on Goods and Services</td>
<td>Yes</td>
<td>135,600</td>
<td>228,000</td>
<td>24.8%</td>
<td>24.4%</td>
<td>4.5%</td>
<td>5.6%</td>
<td>Imputation</td>
</tr>
<tr>
<td>Taxes on trade and international transactions</td>
<td>Part</td>
<td>162,096</td>
<td>153,379</td>
<td>29.7%</td>
<td>16.4%</td>
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<td>3.8%</td>
<td>Imputation</td>
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<tr>
<td>Other taxes</td>
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<td>9,600</td>
<td>61,000</td>
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<td>0.3%</td>
<td>1.5%</td>
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<tr>
<td>Non-taxes revenue</td>
<td>No</td>
<td>28,600</td>
<td>81,000</td>
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<td>0.9%</td>
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<td>Donations</td>
<td>No</td>
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<td>222,124</td>
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<td>23.7%</td>
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<td>5.5%</td>
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<tr>
<td>Total revenue and donations</td>
<td>Part</td>
<td>545,985</td>
<td>936,294</td>
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<td>100.0%</td>
<td>18.1%</td>
<td>23.0%</td>
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**Source:** The authors

<table>
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<tr>
<th>Expenditure</th>
<th>Included in the analysis</th>
<th>2011 Million FCFA</th>
<th>2014 Million FCFA</th>
<th>Share in total Expenditure (%) 2011</th>
<th>Share in total Expenditure (%) 2014</th>
<th>Share in GDP (%) 2011</th>
<th>Share in GDP (%) 2014</th>
<th>Allocation method</th>
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<td>Total expenditure</td>
<td>-</td>
<td>707,616</td>
<td>1,357,273</td>
<td>100%</td>
<td>100%</td>
<td>23.4%</td>
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<td>Social Spending</td>
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<td>178,847</td>
<td>362,036</td>
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<td>26.67%</td>
<td>5.91%</td>
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<td>Social assistance of which</td>
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<td>Scholarships and accessories to tertiary</td>
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<td>9,399</td>
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<td>0.69%</td>
<td>0.18%</td>
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<td>Social support for non-grant tertiary study</td>
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<td>700</td>
<td>1,500</td>
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<td>0.11%</td>
<td>0.02%</td>
<td>0.04%</td>
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<td>Non cash transfer</td>
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<td>618</td>
<td>1,581</td>
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<td>0.12%</td>
<td>0.02%</td>
<td>0.04%</td>
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<td>School feeding</td>
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<td>1,581</td>
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<td>0.02%</td>
<td>0.04%</td>
<td>Simulation</td>
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<td>Transfers in kind</td>
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<td>349,551</td>
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<td>25.75%</td>
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<td>278,350</td>
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<td>168,113</td>
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<td>12.39%</td>
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<td>3,961</td>
<td>59,808</td>
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<td>Tertiary</td>
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<td>50,429</td>
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<td>Health of which</td>
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<td>48,739</td>
<td>71,201</td>
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<td>5.25%</td>
<td>1.61%</td>
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<td>7,856</td>
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<td>0.02%</td>
<td>0.04%</td>
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<td>Central</td>
<td>-</td>
<td>33,266</td>
<td>50,865</td>
<td>4.70%</td>
<td>3.71%</td>
<td>1.10%</td>
<td>1.24%</td>
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<td>-</td>
<td>276</td>
<td>238</td>
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<td>0.02%</td>
<td>0.01%</td>
<td>0.01%</td>
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<td>Diffa</td>
<td>-</td>
<td>242</td>
<td>203</td>
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<td>0.01%</td>
<td>0.01%</td>
<td>0.00%</td>
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<td>Dosso</td>
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<td>341</td>
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<td>0.02%</td>
<td>0.01%</td>
<td>0.01%</td>
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<td>-</td>
<td>448</td>
<td>348</td>
<td>0.06%</td>
<td>0.03%</td>
<td>0.01%</td>
<td>0.01%</td>
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<tr>
<td>Tahoua</td>
<td>-</td>
<td>574</td>
<td>470</td>
<td>0.08%</td>
<td>0.03%</td>
<td>0.02%</td>
<td>0.01%</td>
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<tr>
<td>Tillaberi</td>
<td>-</td>
<td>421</td>
<td>363</td>
<td>0.06%</td>
<td>0.03%</td>
<td>0.01%</td>
<td>0.01%</td>
<td>-</td>
</tr>
<tr>
<td>Zinder</td>
<td>-</td>
<td>1,783</td>
<td>2,645</td>
<td>0.25%</td>
<td>0.21%</td>
<td>0.06%</td>
<td>0.07%</td>
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<tr>
<td>Niamey</td>
<td>-</td>
<td>3,390</td>
<td>8,241</td>
<td>0.48%</td>
<td>0.61%</td>
<td>0.11%</td>
<td>0.20%</td>
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<tr>
<td>Subsidies of which</td>
<td>-</td>
<td>4</td>
<td>5</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
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<tr>
<td>Agriculture</td>
<td>Yes</td>
<td>3.84</td>
<td>5.02</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>0.00%</td>
<td>Imputation</td>
</tr>
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</table>

Source: The authors

Table 7. Impacts of fiscal policy on poverty in Niger, 2011-2014

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<tr>
<th></th>
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<td><strong>2014</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Headcount Index</td>
<td>44.5%</td>
<td>0.0%</td>
<td>44.5%</td>
<td>44.2%</td>
<td>0.0%</td>
<td>44.5%</td>
<td>47.0%</td>
</tr>
<tr>
<td>Poverty Gap</td>
<td>13.2%</td>
<td>0.0%</td>
<td>13.2%</td>
<td>13.1%</td>
<td>0.0%</td>
<td>13.2%</td>
<td>14.4%</td>
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<tr>
<td>Squared Poverty Gap</td>
<td>5.4%</td>
<td>0.0%</td>
<td>5.4%</td>
<td>5.4%</td>
<td>0.0%</td>
<td>5.4%</td>
<td>6.0%</td>
</tr>
<tr>
<td>Fiscal Impoverishment Headcount (out of total population)</td>
<td>0.004</td>
<td>0.00</td>
<td>0.004</td>
<td>0.459</td>
<td></td>
<td></td>
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<tr>
<td>Fiscal Impoverishment Headcount (among of post-fisc poor)</td>
<td>0.96%</td>
<td>0.00%</td>
<td>0.96%</td>
<td>97.72%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Fiscal Impoverishment (PPP per day)</td>
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<td>4542.03</td>
<td>495591.66</td>
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<tr>
<td>Fiscal Impoverishment per Capita</td>
<td>0.03%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>2.7%</td>
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</tr>
<tr>
<td>Normalized Fiscal Impoverishment per Capita</td>
<td>0.011%</td>
<td>0.00%</td>
<td>0.0%</td>
<td>1.2%</td>
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<td></td>
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</tr>
<tr>
<td>Fiscal Gains to the Poor Headcount (out of total population)</td>
<td>0.0%</td>
<td>27.5%</td>
<td>2.7%</td>
<td>1.1%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fiscal Gains to the Poor Headcount (among of pre-fisc poor)</td>
<td>0.0%</td>
<td>61.7%</td>
<td>6.0%</td>
<td>2.4%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total Fiscal Gains to the Poor (PPP per day)</td>
<td>0.00</td>
<td>32462.07</td>
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<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
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<tr>
<td>Normalized Fiscal Gains to the Poor per Capita</td>
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<td>0.001</td>
<td>0.000</td>
<td>0.000</td>
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<td>Headcount Index</td>
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<td>48.4%</td>
<td>0.0%</td>
<td>48.7%</td>
<td>52.3%</td>
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<tr>
<td>Poverty Gap</td>
<td>13.1%</td>
<td>0.0%</td>
<td>13.1%</td>
<td>13.0%</td>
<td>0.0%</td>
<td>13.1%</td>
<td>14.4%</td>
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<td>Squared Poverty Gap</td>
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<td>0.0%</td>
<td>4.9%</td>
<td>4.9%</td>
<td>0.0%</td>
<td>4.9%</td>
<td>5.5%</td>
</tr>
<tr>
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<td>0.001</td>
<td>0.514</td>
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<td>Total Fiscal Impoverishment (PPP per day)</td>
<td>1293.63</td>
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<td>Normalized Fiscal Impoverishment per Capita</td>
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<td>Fiscal Gains to the Poor Headcount (out of total population)</td>
<td>0.0%</td>
<td>23.4%</td>
<td>3.8%</td>
<td>1.0%</td>
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<td>0.002</td>
<td>0.001</td>
<td>0.001</td>
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<td></td>
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<tr>
<td>Normalized Fiscal Gains to the Poor per Capita</td>
<td>0.000</td>
<td>0.001</td>
<td>0.000</td>
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<td></td>
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</table>

**Source:** The authors
References


