Comparison of the tax system progressivity over time: Theory and application with Mexican data

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Abstract

Assessing the progressivity of a fiscal system is relevant to develop a global idea on the extent of redistribution from this tool. More interesting is to assess the evolvement of progressivity over time and how economic shocks and government interventions affect its design. The social performance of fiscal redistributive mechanisms in Mexico continue to receive a growing interest from politicians and research scientists. The aim of this paper is to assess the dynamic of progressivity of the fiscal system in Mexico and its effect on inequality and on polarization, and this during the period of 2002-2012. What distinguish this work is the relevance of the adopted comparison approach of progressivity and where the common support of comparison is imposed. The results of this study confirm the effectiveness of the governmental redistributive mechanisms to decrease post-fiscal income inequality. Based on our estimates, we conclude for a significant increase in the progressivity of the fiscal system over time, and this happening, despite the high persistent levels of polarization and inequality in the country. Finally we find that, imposing the common support of comparison have a non neglected impact on the level of progressivity. For instance, the apparently strong progressivity of the fiscal system lightens down for the initial years when the common support is taken into account.

Key words: Progressivity; redistribution; inequality; polarization; non-parametric analysis.

JEL Classification: D63, I32, O12.

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1 Introduction

The comparison of a fiscal system over time has become one of the relevant issues in the developing world for two main reasons: 1. many of the developing economies have shown signs of fiscal revenues’ exhaustion during the last decades and 2. Not all of these countries have shown a homogenous impact on the issue of redistribution and allocation of transfers to improve the welfare of the population and poverty reduction through time. In recent years, similar countries to Mexico in Latin America like Brazil, Argentina and Uruguay have improved their fiscal conditions as well as its effect through redistribution tackling poverty the most; however there still exists economies with poorly results having applied even more ambitious programs and more resources such as in Mexico with Oportunidades program and others such as in Bolivia and Peru (Lustig, Pessino, and Scott (2013)).

Even though it is not our goal to analyze poverty impacts from fiscal policy changes, in this paper we attempt to study the evolution of progressivity for the tax-benefit system in Mexico over time. This topic has been even more absent in the literature when a formal common support of comparison has not been considered; we aboard this gap.

One of the relevant issues to analyze the period 2002-2012 is the fact that the Mexican Government changed its internal way of conducting both, political and economic decisions, when the opposing party (Partido Accion Nacional) won the elections for the first time in seventy years, and remained in the power for two periods, that is, twelve years (2000-2012). Some changes began to emerge: on one hand, at state-local level the tax systems were so weak and the informal sector grew up to reach sixty percent of the workers (INEGI (2014) and Dougherty and Escobar (2013)) resulting in a low taxable base; and on the other hand, the benefit programs began to grow at a faster phase suggesting that this period should provide an ideal opportunity to examine the determinants of the fiscal incidence and redistribution into the whole population as well as for the contributors.

Also, an interesting feature of this period is the behavior of the tax-benefit system in 2008 and 2010 because it captures the response of Mexico’s fiscal system on the financial 2008/2009 international crisis with the rapid internal increase on food and energy prices, which involved the expansion of generalized consumption subsidies and targeted benefits, as well as an increase in the value-added tax (VAT) general rate from 15 to 16 percent and from 11 to 16 percent for all the six States bordering those of the United States of America (U.S). One problem arising from these sorts of evaluations is indeed, the absence of the common support of comparison across time that may mitigate or mislead the conclusions.

When trying to measure progressivity through time for instance, initial or final conditions need to be considered at least. This is a problem that has not been considered yet by a number of studies and researchers at present days. Arising from this situation is to obtain misleading results that could be influenced by structural changes even in a short period of time. For the period of this research, we have even a greater problem that have to be considered, when structural variables could have been driven income distribution in the recent 2008-2009 international crisis for such a short period of time. We have taken consideration of this singularity and our results then, are fully comparable over time.

The order of the paper is as follows. The next section briefly describes the fiscal context and
its related events during 2002 and 2012 as well as the empirical literature up to date related to progressivity in fiscal systems on international experiences and Mexico; third section describes the theoretical framework; fourth section presents the data sources with the specific assumptions made and the empirical exercise; fifth section concludes and shows the final insights providing new routes for future research.

2 Overview of changes in the Mexican fiscal structure

Serious distortions that result in an excess of inequality persist among the population in Mexico, both in the way of paying taxes as well as the way to receive welfare support through the fiscal system by the Government. While inequities have historical roots in this country, it has been shown how not only for developed but also in developing countries a better redistribution of resources has been achieved through the fiscal systems using compensated-based redistributive policies.\footnote{See Lustig, Pessino, and Scott (2013).}

Another issue of importance is the significant under-reporting of wages by registered firms to evade payroll taxes in the country (Kumler, Verhoogen, and Frías (2013)), as well as the impact of a persistent high level in the informal sector with serious consequences for the marginal efficiency of taxation as one of the causes of low revenue collection. As a research hypothesis, this last issue will lead to an impact on the tax system, even when it is progressive, that is not able to cope with inequality over time.

2.1 The Tax-benefit system behavior in perspective

The tax-burden in Latin America has been low compared to other countries with similar levels of economic development. It has stood by an average of 15 percent for the year 2005 but differences within countries remain large, from about 35 percent in Brazil to as low as 10 percent in Mexico or Guatemala. The trend during the last decade has been towards an increase in the tax burden and its efficiency, mostly for the same countries that initially had the same pattern. Comparing this later issue to public expenditure levels, during the last twenty years there has been a widespread difference among the Latin American economies that seem to be growing departing from 2002.\footnote{See Gomez-Sabaini (2006) for more insights about this process.}

It is important to remark that the taxation structure has remained almost the same for Mexico during 2004-2012 and the main taxation figures have relatively few changes. On one hand, income taxes continued in the margin at the same levels for revenues, and on the other, the VAT has changed in 2010 increasing the general rate from 15 to 16 percent, letting the rest of consumption categories unchanged. Income taxes represent an average figure of 46 percent and VAT an average of 38 percent of the total taxation revenues during the period.

Two new kinds of direct taxes emerged in the country in 2008 called the Corporate Tax flat rate (IETU for its initials in Spanish) as well as the flat Tax of cash deposits (IDE for Spanish initials). The first one as a need to operate with a minimum income tax to improve collection of revenues when controlling for tax elusion, and the second to reduce informality applying a
flat rate of 2 percent for cash deposits greater than 15,000 Mexican pesos (MXN) accumulated per month. This later tax was considered as a complement to the not declared income tax. Both figures accounted for a maximum of 4.1 and 1.3 percent of total taxation revenues respectively in 2011. In 2013, both taxes were eliminated from the fiscal system. Among the causes that engenders the difficulty of the Mexican fiscal system in raising revenues to fund the provision of public goods through the time, it can be found the under-reporting of wages by registered firms (Kumler, Verhoogen, and Frias (2013)) and the high level of informal employment which ranges between 45 percent to 80 percent of total employment across its states persistently during 2005-2010 (Dougherty and Escobar (2013)).

The context of a structural fiscal crisis that characterized the Mexican government for decades highlighted the need to target even more the public expenditures to well-defined sets of populations. The economic policy of the last two decades, engaged in macroeconomic balances failed to be reflected in higher economic growth and much less, in the creation of a more equitable society. On the contrary, deterioration in the living conditions of the Mexican society is evident where approximately more than 50 percent of the population lives below the official threshold.

Even if the combined effect of the different social programs have significantly helped in reduced poverty in Mexico, their effectiveness and sources of finance continue to be questionable. Is it possible to improve the social efficiency of benefits, as well as the tax efficiency to finance in particular the social programs and in general the public projects? The need of continuing improvement in the design of a tax/benefit system is justified by the economic structural changes. For instance, the increase in the tax on the production or consumption of goods may be relevant to compensate the tax payers, especially when the informal sector become the predominant shape of the economic structure (Dougherty and Escobar (2013)).

Mexico needs to restructure its strategies to cope with poverty to improve the social efficiency of its intervention: First, by taking targeting as the single best mechanism to ensure the optimal use of public resources. When it is assumed that any benefit that reaches the non-poor or undesired population it is said to be misused; second, the social policy has not been designed to solve the underlying problem. When transfers translate into a lack of government action and the benefits derived in welfare support just serve as survival for the poor. And third, government in turn invariably has made his standing letter from the social policy, so there is a political bias in targeting fiscal resources to public programs regardless the political party in the power during this time.

In January 2002 the Inter-American Development Bank (IADB) granted Mexico a loan of one billion dollars to support a program called "Oportunidades" and due to great expectations; led to another loan of 200 thousand million to expand the coverage and consolidate it. According to World-Bank (2014) results indicate a decreasing pattern for poverty between 2002-2006 with a poverty national level of 42.9 percent and an increasing one for 2008 and 2010 with a level of 47.8 percent in the former and 51.1 percent in the latter year; it slightly increased its level again in 2012 accounting for 52.3 percent of its population.

Even though parallel to Oportunidades other benefit programs were applied, such as aid to the elderly, to areas with natural disasters or having serious problem for the creation of new jobs,

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4 See CONEVAL (2012) for more insights of this figure and a more disaggregated picture using the multidimensional approach to compute poverty levels in Mexico in the year 2012.
and additional aid on food subsistence for the poor. The welfare aid has shown its inability in reducing poverty on economic crisis. All these benefit programs have accounted for no more than 0.92 percent of Mexican GDP at its highest level.

2.2 Growth and shocks

World-Bank (2014) information reveals that the Mexican economy has struggled with two periods of crises: 2001 and 2009. Both years imposed a deceleration of the GDP growth by -1.5 and -7.1 percent respectively. During the period, evidence of workers employed shifting from the manufacturing sector to services sector was presented. Caamal (2013) shows this pattern associated with lower labor demand in the former sector and falling returns to education.

Along with the previous performance, Government actions have centered on two important features: Applied a generalized consumer subsidies on domestic electricity, gas and diesel, as well as gasoline); and increase from 0.34 to 0.92 percent of GDP in the direct cash-transfer social programs. The former subsidies have varied sharply in recent years as a function of international oil prices behavior: they accounted for a historical maximum of 2.8 percent of GDP in 2008, as a result domestic gasoline prices were frozen in the context of rising international gasoline prices and fell by a half in 2010; however, climbed back to an estimated 2.7 percent of GDP in 2012, despite domestic gasoline prices have an increase of 0.11 Mexican cents for every month paid by the consumers.

During the last nine years, a non-contributory health insurance was introduced to most of the uninsured population called ”Seguro Popular” program, extended mostly to the poor. Population without coverage of neither social security nor protected by any health care program (public or private) could apply. This figure went from 50.1 percent (13.3 million people) in 2006 to 44.1 percent (11.8 million people) in 2008. Between 2008 and 2012 the lack of access to health services decreased significantly to 21.5 percent in 2012 (25.3 million people).

This significant decrease is mainly due to the enrollment to the Seguro Popular system (CONEVAL (2014)). However, the right to health-care in Seguro Popular is not completely free and families must pay an annual registration fee. According to Scott (2013) all these changes have been implemented with a failure to increase Mexico’s capacity fiscal revenues: non-oil tax revenues have remained stagnant at close to 10 percent of GDP, when for the rest of the Latin American countries had raise revenues on average from 13 to 19 percent of GDP in the last ten years. As a result, in Mexico a large fraction of the public spending has been financed through oil revenues which come from the state-owned oil company Petróleos Mexicanos (PEMEX).

Another relevant feature has been the rapid increase in food and energy prices. The financial 2008 international crisis caused a rapid internal increase on food and energy prices in the country. Only basic food registered a nearly 14 percent increase in rural areas and 12 percent for the urban, when inflation rate 5.24 and 5.7 percent in 2008 and 2010 respectively (CONEVAL (2012)). From June 2012 food prices rose back to levels similar to those of 2009. It seems the latter process has sterilized the positive effect induced by the cash benefit programs, and brought part of an increase in the poverty levels in 2010 and 2012.

Campos-Vazquez, Esquivel, and Lustig (2012) found that inequality decreased from 2002-2006 and then returned to its initial level in 2008 using disposable total household income with

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5see Scott (2013) for a more detailed description of the effects of the 2009 crisis in Mexico.
a standard Gini coefficient of 0.51. Inequality decreased again to a level of 0.49 in 2010, and among the factors driven this process in overall inequality they determine the decline in non-labor income inequality and the role exerted by remittances and government transfers. In these years, emigration from Mexico to US grew at a rapid pace as well as remittances sent by these migrants to their families in Mexico. CONEVAL (2009) data provides evidence that excluding remittances, poverty in the country could have been much higher.

2.3 Empirical literature on progressivity

Empirical research has been carried out to measure liabilities, the tax-burden or even the incidence of transfers and benefits over time and across countries (Davidson and Duclos (1997), Keen, Papapanagos, and Shorrocks (1996), Duncan (2010), Araar (2008), Baunsgaard and Symansky (2009), Devereux and Fuest (2009), Buettner and Fuest (2010), Attinasi, Checherita-Westphal, and Rieth (2011), Lustig, Pessino, and Scott (2013), and Scott (2013)).

Davidson and Duclos (1997) found a more progressive distribution in the post-fiscal distribution of income between 1981 and 1990, where using the asymptotic sampling distribution of quintile-based estimators, found that taxes are clearly statistically less progressive than benefits, and gross incomes were more equal in 1981 than in 1990 but for the net incomes the opposite trend was found, so, redistribution was significantly more progressive in 1990 than in 1981.

Keen, Papapanagos, and Shorrocks (1996) extend the core results on progressivity to cover zero tax payments on income tax and prove that any variation in average tax rates is sufficient to admit the possibility that residual progression is reduced by an increase in either, allowances, income-related deductions, or tax credits. Wagstaff and van Doorslaer (2001) analyzes the role of tax credits, rate structures, allowances and deductions in determining the overall progressivity of net income tax liabilities in fifteen OECD countries and three kind of clusters have been found, when the rate-structure in countries like Australia, France, Italy, the Netherlands and Spain have the rate effect as the dominant (but not the only) source of progressivity of gross and net tax liabilities; the allowance countries as the English-speaking countries where allowances are the dominant source of progressivity; and the mixed structure countries, Belgium, Finland, Germany and Sweden, where roughly half of the progressivity of gross tax liabilities is attributable to the rate structure.

Araar (2008) performed an empirical application for progressivity using the Canadian data to estimate the impact of the fiscal system on the size and wellbeing of socio-economic classes. He concludes for the progressivity of the fiscal system that enables to reduce the size of poor and increase the middle class, according to an increasing progressivity pattern of fiscal system in the country between 1993 and 2005.

On the other hand, Duncan (2010) found that tax progressivity may increase current inequality, especially in countries having a weak law and a large informal nontaxable sector where the evidence is estimated for over one hundred countries worldwide. Duncan (2010) findings suggest that progressivity has a strong negative effect on inequality in reported gross and net income and that this negative effect is stronger in countries whose institutional framework supports pro-poor redistribution. A similar pattern was found in Claus, Martinez-Vazquez, and Vulovic (2013) for many Asian countries, where government
spending on social protection appears to increase income inequality instead of coping with it.

The research conducted by Baunsgaard and Symansky (2009) highlight the importance for analyzing income taxes for several reasons, among them is that these sorts of taxes are more progressive than corporate or consumption taxes over time. Other findings reveal that corporate taxes are not found to act as significant automatic stabilizers in the economy cycle (Devereux and Fuest (2009), and Buettner and Fuest (2010)). Also, Attinasi, Checherita-Westphal, and Rieth (2011) using a direct measure of personal income tax progressivity found how income taxes payable by individuals seems to be more important in terms of budgetary revenues than corporate income taxes for many developed EU economies. They present OECD cross-country evidence on the relationship between tax progressivity and output volatility.

Lustig, Pessino, and Scott (2013) provide good insights in pursuing the progressivity incidence for the fiscal system figures of six Latin American countries and its impact on poverty during 2000-2010, their results show that a more progressive tax-benefit system is found for most of the selected countries in recent years with markedly differences, where Bolivia, Mexico and Peru have the lowest impacts on poverty reduction, while Argentina, Uruguay and Brazil presented the greatest reductions and are the countries with the most redistributive fiscal systems.

Scott (2013) presents a complete analysis for a short period of time, between 2008 and 2010, for the fiscal tax-benefit system in Mexico. He finds a situation that describes a fiscal system trapped in a low-revenue-low-benefits equilibrium, where this limitation of tax revenues does not arise from exceptionally low tax rates, but from low levels of tax productivity. His findings show a more progressive fiscal system in 2010, but this strategy treats both years not as a single episode of tax design, but as a comparative static measurement of progressivity when just using each tax and benefit rules for each year.

Although Lustig, Pessino, and Scott (2013) and Scott (2013) have done a great job in processing the tax figures and transfers in their databases, their progressivity findings lack of absence of the common support of comparison, so it cannot assure those are reliable because fiscal incidence and progressivity refers only to the relative structural conditions separately for each year, then measured at only one point in time without observing the relativity incidence with respect to the changes on income distribution.

3 Theoretical framework

In this section, our main objective is to present the used theoretical framework in this study by focussing on how to:

- assess the progressivity of a fiscal/benefit system.
- make a comparison of progressivity over time.
- assess the distributive impact of the fiscal/benefit system.

We start by introducing the way in which the progressivity can be tested and measured, then, by explaining the inequality and polarization indices that can be used to assess the behavior in income disparities and on polarization of income from a response due to the tax-benefit action.
3.1 Testing progressivity of fiscal system

Usually in distributive analysis, we assess the progressivity of taxes or transfers. However, with governmental intervention through the fiscal system, the household can have, depending on its characteristics, a simplified negative or positive impact on its gross income. First, we begin by dividing the total impact of the fiscal system on household income, which is the difference between net and gross income, into two main components. If the impact at household level is negative, we assume that the latter represents a global tax, noted by $T$ that the household must pay. In contrast, if the impact is positive, this represents a global transfer that the household receives and we denote it by $B$. It can be said that a tax is progressive if the tax burden of the poor group is relatively lower than that of the non-poor group. This implies a rise in the share of net income for the poor group. In the literature of progressivity, there are two main distinct concepts of progressivity, which are the local progressivity (LP) and the global progressivity (RP).

Let $V(x)$ denotes the final impact on gross income $x$, such that $V(x) = B(x) - T(x)$.

Theorem 1 With the liability progression measurement, a fiscal system with tax $T$ and transfer $B$ is locally progressive if and only if:

$$LP(x) = \frac{B(x)}{x} \eta_B(x) - \frac{T(x)}{x} \eta_T(x) - \frac{V(x)}{x} < 0,$$

where $\eta_T$ and $\eta_B$ refer to the elasticities of tax $T$ and transfer $B$ with respect to income $x$ respectively.

Proof. This condition can be easily derived starting from the initial condition of local progressivity of the net benefit $V(x)$, which is: $\eta_{V(x)} < 1$.

It can be recalled here that with the residual progression measurement, a fiscal system with tax $T$ and transfer $B$ is locally progressive if and only if:

$$RP(x) = \eta_{N(x)} < 1,$$

$\eta_{N(x)}$ refers to the elasticity of the net income $N(x)$ with respect to income $x$. To test the global progressivity of a fiscal system, we use two dual approaches. The first is the Tax Redistribution approach ($TR$), which is based on the distribution of taxes considering that of gross income. The second is the Income Redistribution approach ($IR$), which is based on the distribution of net income considering that of gross income.

Theorem 2 A fiscal system with tax $T$ and transfer $B$ is globally TR progressive if and only if:

$$TR(p) = \frac{\mu_T}{\mu_X} [L(p) - C_T(p)] + \frac{\mu_B}{\mu_X} [C_B(p) - L(p)] > 0 \quad \forall p \in [0, 1],$$

where $L_x(p)$ and $C_x(p)$ denote the Lorenz and concentration curves respectively at percentile $p$, and where $\mu_T$ and $\mu_B$ are the average tax and average transfer respectively.
Proof. The link between concentration curves and progressivity was already developed by Kakwani (1977), Araar (2002) and Duclos and Araar (2006), prove that the proposed hybrid curve is equal to the change in Lorenz curve with a marginal change in taxes and transfers.

It can be checked easily that if $TR(p)$ is greater than zero for all the range of percentiles, and in absence of re-ranking, the redistributive effect of this fiscal system is socially efficient and inequality must decrease. Instead of comparing between Lorenz and concentration curves it can be used progressivity indices. The aim of these indices is to capture the whole progressivity with one synthetic index. In general, these indices are computed as differences between the Gini and concentration indices.

Corollary 3 A fiscal system with tax $T$ and transfer $B$ is progressive if the index of progressivity:

$$\frac{\mu_T}{\mu_X} [IC_T - IG_X] + \frac{\mu_B}{\mu_X} [IG_X - IC_B] > 0,$$

where $IG$ and $IC$ are the Gini and concentration indices respectively. For the $IR$ approach, one can recall that the fiscal system is $IR$ progressive if:

$$IR(p) = \left[C_{X-T+B}(p) - L_x(p)\right] > 0 \forall p \in [0, 1],$$

Using Gini and concentration indices, one can recall that the fiscal system is progressive if:

$$IG_X - IC_{X-T+B} > 0.$$

3.2 Comparison of progressivity over time

To assess the nature of change in progressivity of any fiscal system over time, it is a wrong practice to compare the yearly estimated progressivity indices. Indeed, in this case, the absence of the common support of comparison of the distribution of incomes across years mitigates our conclusion. Actually, the change in the pre-tax income distribution affects substantially the progressivity measurements, even with an unchanged fiscal system. The less equal the pre-tax income distribution is, the greater will the equalizing effects be and hence, the higher the progressivity index will be. Hence, progressivity indices cannot be compared with the change in the distribution of gross income from one year to another.

To address this issue, we propose comparing between progressivity indices or curves, when the reference year is predetermined. For instance, to compare the progressivity of a tax/benefit system between periods 1 and 2, when the period of reference is the first, the expected taxes and transfers from period 1 can be estimated, using information of period 2 (incomes, taxes and transfers for period 2). Practically, for our application, we use the locally linear non parametrical approach to estimate these expected taxes and transfers. The same exercise may be done using period 2, as a period of reference. If we do not like to be concerned by a given period of reference, the Shapley approach can be used to avoid the arbitrariness in selecting the reference period.

6See Duclos and Araar (2006), chapters 7 and 8.
7For the measurement of the global progression, Musgrave and Thin (1948) has proposed to use the relative change in equality implied by the tax. However they note that this change depends on the initial distribution of pre-tax income.
9See the Appendix 1.
3.3 Inequality and polarization

In this study, we use the popular Gini index to assess the levels of inequality in gross and net incomes. This will enable to show by how much the tax/benefit system reduces the income disparities. Also, we assess the impact tax/benefit system on polarization, measured by the Foster and Wolfson (1992) (FW) and Duclos, Esteban, and Ray (2004) (DER) indices to assess bipolarization and polarization respectively. Formally, the normalized DER index can be written as follows:

\[ P_{DER}^{\alpha} = A \int \int f(x) \left( 1 + \alpha f(y) \right) |x - y| dy dx, \]

where \( A = 0.5 \mu^{\alpha-1} \) and \( f(.) \) is the density function. Keep in mind that, when the parameter \( \alpha = 0 \), the normalized DER index equals the usual Gini index. The question that can now be raised is: How do polarization indices differ from those of inequality? While inequality measurements are conceived to assess the expected divergence or disparity between incomes, polarization measurements are also sensitive to the level of identification of groups through income. For a given population group delimited by a small income range, its identification increases with its population share. Furthermore, it has been argued for the evident link between polarization and some other negative aspects of the distribution. For instance, severe poverty, disappearance of middle class or higher level of between-group inequality are certainly related with polarization phenomenon.

Now, we review the adopted bipolarization measurement. Bipolarisation can be viewed as a special case of polarization when one focuses on the level of disparity and identification of the two main groups of the population. For the FW index, the first group is composed from those with income bellow the median and the second with income above this threshold. An interesting representation of this index was proposed by Rodriguez (2004):

\[ P_{WOLF} = 2 \mu \frac{m}{m} \left[ IG_B^m - IG_W^m \right] \]

where \( IG_B^m \) and \( IG_W^m \) are the between and within inequality components, when the Gini index is decomposed by the two population groups, separated by the median of income \( (m) \). Hence, the FW index reaches its maximum when the first half of the population has a null income and the second one shares equally the total income. In general, any distributive change, which increases the average income of the rich group will increase bipolarisation measurements. In addition, a decrease in inequality within any of these two groups will increase the bipolarisation (groups will be more identified through income). In summary, this index gives us synthesized information about the level of disparity in average income between the two main groups of population and how these two groups are homogeneous based on their income levels.

4 Application

4.1 The Mexican household income and expenditure surveys: The ENIGH databases

For the empirical exercise we unified a series of the ENIGH surveys considering 2002, 2004, 2006, 2008, 2010 and 2012 years and deflated incomes using a Consumer Price Index with 2012 as a base year and the month of August when the surveys have been collected. Based on the information provided by its microdata and to make it comparable to the official reports we proceed to build the distribution according to CONEVAL equivalence scale and following both, direct and indirect identification methods.\(^\text{11}\)

4.2 Microdata for Mexico and construction of the fiscal system

Once disposable household equivalent income (denoted by N) is obtained, it is possible to calculate the figures shown in table 1 to rebuild the pre-fiscal (Market equivalent income) denoted by X. When the vector on N is obtained after taxes, the current tax rules per each source of income are applied for each survey. The Mexican tax system has a scheme of limits and quotas for the assessment of the income tax (ISR) with 8 brackets of income in total. Each bracket must pay the corresponding income fee in Mexican pesos \([0.00, 114.24, 2,966.76, 7,130.88, 9,438.60, 13,087.44, 39,929.04, 73,703.40]\), as well as a percentage of the salary for the marginal income tax ranging from 1.92 percent up to 30 percent in the most current fiscal year of 2012. The surveys allow obtaining sources of incomes and we use the four addressing to ISR.\(^\text{12}\)

Thus, different tax schedules were taken into account for the taxpayers, tax credits and tax allowances per wage-earners were used as well. In order to rebuild the fiscal system from N in the surveys the taxes translation hypothesis in Pechman (1985) are considered.\(^\text{13}\) For the empirical exercise, we use the income tax from both wage-earners and individuals that reported income sources as benefits obtained from business, so we are able of estimating the progressivity and incidence for these sorts of direct taxes in the survey. It can be seen in figure (1) that the income tax reforms in the last decade were modest with no great changes over the ranges of income, so we should not be expecting for the given income tax rates, a great variability and impact on public revenues. From a maximum rate level of 33 percent in 2004, it decreased to 28 percent in 2008 and raised again to a level of 30 percent in 2010 and 2012.\(^\text{14}\)

In the case for indirect taxes, it was obtained the VAT and IEPS (special tax on production and services) where these two indirect taxes are the most important for revenues after income

\(^{11}\)See for instance Lustig, Pessino, and Scott (2013).

\(^{12}\)These are: 1. Wages and salaries, taxable benefits, commissions, incentives (wage-earners); 2. Income from business and utilities; 3. Capital and financial earnings (includes insurance and other payments as income from investments); and 4. Formal income from self-employment (only those officially registered covered by any social security institution).

\(^{13}\)These are related to the income tax which is paid in accordance with the legal framework and not translated, and for indirect taxes such as VAT and IEPS which are paid completely by the consumers.

\(^{14}\)Along with the corresponding income tax rate, the tax quota must be added for each income bracket.
For those indirect taxes we estimated them according to the tax rules and controlling by informal activities related to the place of purchase provided in the same survey.\textsuperscript{15}

The border with the U.S has a special VAT treatment different from the rest of the country, so this has been controlled applying 11 percent to the expenditures located in all these cities included in the survey and, 10 percent for all the previously surveys used as well. We believe this process does not add taxes beyond the actual paid by taxpayers.

In the case of benefits we collect them at the household level from the same surveys using the following: scholarships and cash transfers for education; "Oportunidades" program; 70 and more (for the elderly without pension); "Programa de Apoyo Alimentario" (PAL for its initials in Spanish, standing for program for food assistance); transfer for temporary employment; and finally, other assistance programs.\textsuperscript{16} At the end, market income is estimated just adding the total taxes and federal contributions from wages to the social security system (SSC) minus pensions and the cash-benefits received at a household level.

\textsuperscript{15}We have considered the 15 different places reported in the survey where at least five do not collect VAT nor IEPS. We believe this adjustment lead us to a situation when VAT is not overestimated and then, an underestimation of VAT is preferred. Those places not contributing for indirect taxes are Flea markets and street vendors, purchases outside the country, others known as "loncherías, fondas, torterías" as informal cafeterias, taquerías or street dining places, Canteens or informal bars (Pulquerías in spanish), and last but not least, the informal freelance vendors not officially registered according to the survey.

\textsuperscript{16}There is no clear approach to use pensions as a benefit component, or at least the share of pensions added by the public sector. In our case, we treat pensions as in the research of Cok, Urban, and Verbic (2013) and Lustig, Pessino, and Scott (2013) not adding retirement and pensions as a benefit component because of its contributive nature; but including it in the net income figure.
4.3 Unit of analysis and indicator of wellbeing

There is a consensus on the relevance of using the individual as the main unit of distributive analysis and to ensure an accurate estimation of wellbeing for household members. Hence, the primary step is to assess wellbeing of individuals and one has to adjust the total household income by the family size and its composition. The simplest method is to use per capita income, that is, to divide the household income by the household size.

In our case, we use the equivalence scale from CONEVAL to account for social welfare which considers four different values to equalize income according to the value of one for the household head plus the corresponding values for the ages of each member in the household, ranging as follows: [0-5]= 0.7, [6-12]= 0.74, [13-18]= 0.71, and [19-65+]= 0.99. In this sense we are comparing equal units affecting the shape on the distribution when giving the corresponding weight to each household member as well as assigning the respective weights of the official economies of scale for the Mexican households.

4.4 Composition of population and household wellbeing

A useful method to have a complete picture on the shape of distribution of wealth is to draw its density function. For this purpose, we have selected three years of surveys in the period (2004, 2008 and 2012) and estimates are carried out using the Gaussian corrected boundary kernel estimator to its density functions. Indeed, the usual kernel estimation will be biased when close to the minimum bound. In our data this is explained mainly by the high frequency of population with low or null market income.

Figure 2: Density curves of gross incomes

Figure 3: Density curves of net incomes

In figures (2) and (3), we plot density functions of gross and net income respectively. This first remark concerns the shift of the density curve of net income to the right side between years of 2004 to 2012. This shift indicates that household wellbeing have increased on average during this period. The other remark concerns the change in shape of the density function of gross income where the latter began to be flatter. Let’s remind here that inequality is inversely linked with the kurtosis of the distribution. To clarify this better, for flatter density functions, the

17A high kurtosis distribution has a sharper “peak” and flatter “tails”, while a low kurtosis distribution has a more rounded peak with wider “shoulders”. All estimates reported in this paper are done with Stata, DASP and DAD packages. See also Araar and Duclos (2007).
population size of the poor and rich groups is relatively much greater and the expected disparity in income or inequality is higher as well. Also, for gross income, we observe the shift of the density curve of net income to the right side between the years of 2004 to 2012. However, for the year of 2008, the density curve has moved more to the left side to mark the negative impact of the world economic shock of 2007/08.

Now we shed the light on the main factors that can explain the change in average income during the studied period. In figure 4 we start by presenting the trend of some basic macro-economic indicators. Among the important remarks, one can observe the clear negative impact of the world economic shock of 2007/08 on the Mexican real gross domestic product. The inflation rate remained practically constant, but not so for food inflation, the unemployment rate has registered some increase during the world economic crisis. Note that even in the case of constant returns in endowments (real wage for instance), the change in the composition of population, expressed by the change in proportion of active population, may influence the variation in average income. The trend of real GDP plotted in figure 4, indicates that there has been presented a substantial economic improvement at the end of the studied period, after its level plummeted in 2009 by 7.1 per cent. However, the trend of active population rate shows some increase in the proportion of active population.

This conclusion is also confirmed in figure 5 where the expected household size for a given level of gross income has decreased over time. An increase in welfare through the change in the composition of population, or equivalently, a decrease in the ratio of dependence may be temporal. The renewal of active population must be perceived as an inter-generational investment to ensure the availability of the adequate size for the active population in the long term. While the proportion of children in the population was about 45.87 % in 1960, the later has decreased to about 29% in 2012. It may be helpful to look for the demographic policies to remedy the need of adequate active population for the next generations and its impact on fiscal policy.

Figure 4: The trend of Mexican macro-economic indicators

Figure 5: Expected household size according to household gross income

4.5 The trend of inequality and polarization

As reported in section Theoretical framework, inequality indices are useful to summarize the information about the disparity between personal incomes. In table 1, we present the trend
of inequality in gross and net incomes for the period between 2002 and 2012. Starting from the results of this table, one can conclude what follow:

- There has been a slight decrease in inequality between 2002 and 2012 for both, market and net incomes. However, this decrease was large just after the word economic shock of 2008. Araar (2012) reports that the inequality in Latin American countries has decreased just after the word economic shock of 2007/08. His work describes the inequality decrease is explained by the large impact of those that are ease and the benefit programs that target the deprived group.

- Over time, the impact of the fiscal system seems to be linear and depends mainly on the shape of the distribution of gross income. This conclusion is based, in part, on the stable impact of the fiscal system on inequality, buy only for each year (not cumulated). This may be attributed to the rigidity of adjustment of the fiscal system over time or to its delay to respond to the punctual economic shocks, and then regain its initial level for the next period. The reduction in the Gini index implied by the fiscal system is about 4 points in the index (around 6 percent in change for every year).

- Through the time, there has been a substantial decrease in the iter-region inequity when we consider those that are in the northern border zone and the rest of the country.

<table>
<thead>
<tr>
<th>Year</th>
<th>Gini index (Gross income)</th>
<th>Gini index (Net income)</th>
<th>Change in (%)</th>
<th>Between regions inequality (Gross income)</th>
<th>Between regions inequality (Net income)</th>
<th>Change in (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0.559</td>
<td>0.520</td>
<td>-0.070</td>
<td>0.025</td>
<td>0.024</td>
<td>-0.035</td>
</tr>
<tr>
<td>2004</td>
<td>0.545</td>
<td>0.508</td>
<td>-0.066</td>
<td>0.025</td>
<td>0.024</td>
<td>-0.028</td>
</tr>
<tr>
<td>2006</td>
<td>0.542</td>
<td>0.509</td>
<td>-0.061</td>
<td>0.014</td>
<td>0.014</td>
<td>0.048</td>
</tr>
<tr>
<td>2008</td>
<td>0.556</td>
<td>0.522</td>
<td>-0.060</td>
<td>0.018</td>
<td>0.018</td>
<td>-0.044</td>
</tr>
<tr>
<td>2010</td>
<td>0.530</td>
<td>0.494</td>
<td>-0.068</td>
<td>0.007</td>
<td>0.008</td>
<td>0.117</td>
</tr>
<tr>
<td>2012</td>
<td>0.548</td>
<td>0.513</td>
<td>-0.064</td>
<td>0.015</td>
<td>0.016</td>
<td>0.037</td>
</tr>
</tbody>
</table>

Table 2: The trend of polarization in Mexico

<table>
<thead>
<tr>
<th>Year</th>
<th>DER index (α = 0.75) (Gross income)</th>
<th>DER index (α = 0.75) (Net income)</th>
<th>Change in (%)</th>
<th>FW index (Gross income)</th>
<th>FW index (Net income)</th>
<th>Change in (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0.290</td>
<td>0.284</td>
<td>-0.020</td>
<td>0.522</td>
<td>0.463</td>
<td>-0.113</td>
</tr>
<tr>
<td>2004</td>
<td>0.294</td>
<td>0.269</td>
<td>-0.084</td>
<td>0.496</td>
<td>0.451</td>
<td>-0.090</td>
</tr>
<tr>
<td>2006</td>
<td>0.263</td>
<td>0.245</td>
<td>-0.066</td>
<td>0.490</td>
<td>0.445</td>
<td>-0.090</td>
</tr>
<tr>
<td>2008</td>
<td>0.258</td>
<td>0.249</td>
<td>-0.035</td>
<td>0.518</td>
<td>0.474</td>
<td>-0.085</td>
</tr>
<tr>
<td>2010</td>
<td>0.240</td>
<td>0.230</td>
<td>-0.042</td>
<td>0.501</td>
<td>0.450</td>
<td>-0.102</td>
</tr>
<tr>
<td>2012</td>
<td>0.267</td>
<td>0.258</td>
<td>-0.031</td>
<td>0.505</td>
<td>0.458</td>
<td>-0.094</td>
</tr>
</tbody>
</table>

Now, we focus on the evolution of polarization in Mexico and how governmental interventions, through taxes and transfers, have reduced its level. In table (2), we present the trend of the
DER polarization index for gross and net incomes. Polarization in gross incomes has decreased considerably between 2002 and 2012. The registered decrease in polarization of net income was low over time. Using the Foster and Wolfson (1992) bipolarisation index, we arrive practically to the same conclusion. Obviously, the fiscal system has contributed, but slightly, in reducing bipolarization of net income.

4.6 The evolution of progressivity in the fiscal system

We start our discussion by showing the progression in the effective marginal tax/benefit rates. First, let us recall that for a given level of gross income, the effective tax rate shows the expected total taxes (direct and indirect) for an additional earned peso\(^\text{18}\). For instance in 2012, those with an equivalent gross income of 3 800 MXN, must pay for an additional earned unit of income a total tax of about 0.13 cents. Figure 6 shows that this effective tax rate has decreased drastically during the last years. This can be explained potentially by a set of combined factors such as:

- The increase in informal sector (this enables to avoid taxes and regulations);
- Corporate tax evasion and ineffective corporate tax alleviation (as confirmed by Kumler, Verhoogen, and Frias (2013)).

Either way, the found results tell us about the urgent need of revision in the Mexican tax systems to enhance its effectiveness. In figure 7 we show the effective marginal benefit rate. It can be seen in this figure that the marginal decrease in benefit resulted by an additional earned peso is higher in 2012 compared to the other years, and this especially for poor. This result requires some clarifications. First, the decrease can be greater if the group receives a high level of benefits. Of course, this was the case for Mexico in 2012. Second, with the presence of an efficient mechanism of targeting the poor, if they start earning more income they will lose the assistance through a decrease in benefits. These two combined effects make the effective marginal benefit curve be more steeper for the year of 2012. This indirectly informs us about the progressive nature of distribution of benefits in Mexico, regardless of the real impact on the levels of poverty.

\(^{18}\)These curves are estimated based on the local linear approach. See the Appendix 1 for more information.
Has the Mexican fiscal system become more progressive over the last years? To respond to this question, we use the local and global measurements of progressivity. To test the local progressivity of the fiscal system, we show in figures 8 and 9 the liability and the residual progression curves. Starting from these results, an improvement in local progressivity of the Mexican fiscal system is confirmed, especially for the poor group.

Figure 8: Liability progression curves

Figure 9: Residual progression curves

Now, we present and discuss the global progressivity indices. As reported in table 3 as well as, figures 10 and 11, it can be concluded that the fiscal system was progressive for each of the studied years. The other remark promptly drawn from this event, is the apparently small increase in progressivity of the fiscal system during the last years. However, one must be prudent on this conclusion. As indicated in the theoretical framework section, the absence of the common support of comparison of the distribution of gross income across years may mitigate our conclusion. Otherwise, progressivity indices cannot be compared with the change in distribution of gross income from one year to another.

To remedy this, we use the year of 2012 as the base pre-tax income year (market income in our case) and then we estimate the expected net income in 2012 if the fiscal system of 2004 or 2008 were applied. To estimate the counterfactual vector of net incomes of 2012, based on the fiscal system of a given precedent year, we use the locally linear non-parametric estimation approach. It follows that, for each value of gross income found in the survey of 2012, we use information on gross and net incomes of the given precedent year to estimate the expected net income. Obviously, this procedure does not give us any information about the expected local variability of net income. Fortunately, this local variability does not affect as much the estimation of the progressivity indices.

This is explained mainly by the fact that concentration indices -curves- weight locally the average level of tax or net income according to the rank of the gross income. Results concerning the evolution of the fiscal system’s progressivity, when the base pre-tax income year is that of 2012, are reported in table 4 and figures 12 and 13. Among the most important conclusions, a large increase in progressivity of the fiscal system can be found between 2002 and 2012. The second finding concerns the reverse position of progressivity by considering the common support of comparison of the distribution of gross income across years.

\[ \text{Note that all estimates were done using the Stata package DASP (Araar and Duclos (2007)). Local progressivity curves require, inter alias, the use of the non parametric and the derivative non parametric regressions. For more information, see Appendix 1 at the end of the paper.} \]
support of comparison for the year of 2004. The other remark is the non-neglected impact of change in pre-tax income on progressivity indices.

Table 3: Evolution of the fiscal system progressivity in Mexico

<table>
<thead>
<tr>
<th>Year</th>
<th>TR approach</th>
<th>IR approach</th>
</tr>
</thead>
<tbody>
<tr>
<td>2002</td>
<td>0.0485</td>
<td>0.0586</td>
</tr>
<tr>
<td>2004</td>
<td>0.0512</td>
<td>0.0593</td>
</tr>
<tr>
<td>2006</td>
<td>0.0453</td>
<td>0.0524</td>
</tr>
<tr>
<td>2008</td>
<td>0.0469</td>
<td>0.0507</td>
</tr>
<tr>
<td>2010</td>
<td>0.0561</td>
<td>0.0606</td>
</tr>
<tr>
<td>2012</td>
<td>0.0564</td>
<td>0.0606</td>
</tr>
</tbody>
</table>

Our results are comparable to those obtained for Canada in Araar (2008), where the progressivity level of its tax-system declined from 1996 to 2005 with indices of 0.147 and 0.122 correspondingly; then, using common support of comparison (taking as base the pre-tax income year of 2005) the level of progressivity slightly increased, with indices of 0.1152 in 1996 and 0.1222 in 2005 using the TR approach. So, it can be confirmed the importance of taking into account the common support of comparison and the relevant aspects to consider in fiscal policy design.
5 Conclusion

This paper focuses on the evolution of the progressivity of the fiscal system in Mexico, as well as, in the experienced change in inequality and in polarization of market-income and post-fiscal income distribution between 2002 and 2012. In addition to the macroeconomic performance criteria, the experienced change in the distribution of wealth must be assessed and analyzed over time. It has been argued that a macroeconomic performance may help to increase the overall wellbeing, but it does not guarantee a more equitable distribution of wealth. Over time, there are many factors that can contribute to the reshaping of the distribution of income. In addition to economic growth, other issues like market forces, population endowments and fiscal system measures can influence largely the distribution of wealth. In Mexico, both the fiscal system and social programs should be crucial tools for reducing disparities on income in a faster pace.

In general, with these governmental interventions, the deprived group of contributors and their families receive a special treatment. Indeed, the government ensures a worthy standard of living to the socially excluded group and help them be reinserted into the economic activity sphere. For instance, the Mexican government is not able to finance programs of re-qualification for the people to join the labor market or to be maintained in it, or to provide valuable financial benefits for employers and new coming entrepreneurs as long as it maintains such a low taxable base.

To assess the evolution of the different distributive phenomena, we used the national representative ENIGH surveys and we chose net equivalent income as the indicator of wellbeing for Mexican households. Developed and most updated distributive tools are used to assess and to understand better some links between the studied distributive phenomena. The following summarizes the main conclusions of this study:

- Household wellbeing has registered a significant increase during the last decade. However, it can be noticed the important change in active population rate and an slight decrease in the dependency ratio, which raise the question about the optimal demographic growth and its link on the fiscal system over time.

- While inequality in market and net incomes remain high over time, it can be seen that
for every year, the fiscal system induces redistribution by about 4 percent. More importantly, the follow-up of the evolution in the regional inequality enabled us to conclude for the decrease in the inter-region component which gives insights of a lesser extent of the progressivity impact for this region in the norther border of the country.

- The structure of social classes in Mexico has not registered a significant change during the last decade as shown by the polarization indices.

- Results concerning the trend of polarization or bipolarisation in distribution of incomes are not far from those of inequality, but lower indices in the former are the result of a more cohesion group in the lower tail of incomes.

- Only a higher level of economic growth combined with a large and efficient social program can reduce drastically poverty in Mexico, or even, in the rest of developing countries.

- The yearly progressivity of the fiscal system was confirmed using two measures. For the comparison of progressivity across time, the main conclusion concerns the non neglected impact of change in pre-tax income on progressivity indices. The other is the increase in the progressivity of the fiscal system in 2012 -when the same base pre-tax income is used for different periods-, and last but not least, a low efficiency on marginal taxation detected over time.

Note that conclusions and remarks drawn from this study can help policymakers undertake optimal strategic fiscal policies to enhance the social performance, such as the endurance to expel the non-compliance of (the well-established) firms in collecting taxes. The other contribution of this study is on the development of methods to assess the progressivity of the fiscal system. Our method of distributive analysis carried out considering the Mexican case can be replicated at State or even at a regional level. Finally, we want for this research to inspire future works that investigate impacts of a wide variety of taxes and benefits through time on specific groups of contributors, such as entrepreneurs, self-employed or the poor ones, in order to improve both the fiscal and social policy agenda of the governmental action.
References


Appendix 1  Non-parametric regression and the derivative  
non-parametric regression

Non-parametric regression is useful to show the link between two variables without specifying beforehand a functional form. It can also be used to estimate the local derivative of the first variable with respect to the second without having to specify the functional form linking them.

\textit{Nadaraya-Watson approach}: A Gaussian kernel regression of \( y \) on \( x \) is given by:

\[
E(y|x) = \Phi(y|x) = \frac{\sum_i w_i K_i(x) y_i}{\sum_i w_i K_i(x)} \quad (A.1)
\]

where

\[
K_i(x) = \frac{1}{h \sqrt{2\pi}} \exp \left( -0.5 \lambda_i(x)^2 \right) \quad \text{and} \quad \lambda_i(x) = \frac{x - x_i}{h} \quad (A.2)
\]

From this, the derivative of \( \Phi(y|x) \) with respect to \( x \) is given by:

\[
E \left( \frac{dy}{dx} | x \right) = \frac{\partial \Phi(y|x)}{\partial x} \quad (A.3)
\]

\textit{Local linear approach} The local linear approach is based on a local OLS estimation of the following functional form:

\[
K_i(x)^{1/2} y_i = \mu(x) K_i(x)^{1/2} + \mu'(x) K_i(x)^{1/2} (x_i - x) + v \quad (A.4)
\]

or, alternatively, of:

\[
K_i(x)^{1/2} y_i = \alpha(x)^{1/2} + \beta K_i(x)^{1/2} (x_i - x) + v \quad (A.5)
\]

Estimates are then given by:

\[
E(y|x) = \alpha \quad (A.6)
\]

and

\[
E \left( \frac{dy}{dx} | x \right) = \beta \quad (A.7)
\]