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Abstract

The present paper assesses the impacts of renewable energy generation and globalization on income inequality in Argentina. We make use of vector autoregression models. We find that globalization and hydroelectric power increase inequality, while the opposite holds true for other renewable energy sources. Several robustness checks are considered. Policy implications are discussed keeping into account the specific Argentinean context.

Keywords: Argentina, VAR, energy sources, inequality, globalization

JEL Codes: Q20, Q40, F60, F63, D63.

Introduction

Economists have traditionally been interested in the connection of energy and macroeconomic magnitudes. A classical research topic is, for instance, the energy consumption-output nexus, which recently took into consideration renewable energy sources too (see for example Bilgen et al., 2004; Apergis and Payne, 2012, 2013)[1]. The present paper investigates a new topic: namely the effects of globalization and renewable energy generation on income inequality. Interestingly, these phenomena have not been considered together so far.

We chose a specific country for our analysis, namely Argentina. We did so for various reasons. Among developing countries, Argentina has excellent information in the World Development Indicators database with respect to the variables of interest. Furthermore this country has had a relevant weight in the international economics debate since the 2002 peso crisis (Fanelli, 2002; Hayo and Neuenkirch, 2013). In addition, in Argentina globalization first increased and then decreased. We hope that the variability of our index of economic globalization will help us to better identify its effect on inequality. Furthermore, the peso crisis was followed by a period of relevant economic growth (Herrera and Tavosnanska, 2011). However, this revived growth did not fully translate into a more equitable society (Groisman, 2008). Therefore, exploring further determinants of income inequality in the country under analysis is still challenging. Finally, Argentina has a considerable unexploited potential with respect to renewable energy generation, as it mainly relies on fossil fuels (Guzowski and Recalde, 2008; see also the descriptive statistics below). So if we find that it can affect inequality, there will be one more important reason to encourage its development.

The link between globalization on one side and inequality on the other has been widely explored. Various literature surveys are available by now. Crinò (2009) focuses on studies concerning off-shoring and wage inequality between skilled and unskilled workers, concluding that, in originating countries, the former increases the latter one. Kurokawa (2012) reviews contributions on trade and wage inequality. This link is the subject of heating debate as most of the literature considered skill biased technical change the main

[1] Surveys are available in Lee (2005, 2006), Yoo (2006), Chontanawat et al. (2006) and Payne (2009, 2010a, 2010b) and a meta-analysis in Bruns et al. (2013).

factor behind increasing inequality worldwide. Nonetheless, there are some contributions stressing the link between trade and wage inequality. For instance, Feenstra and Hanson (1996) points to the fact that off-shoring increases wage inequality in receiving countries too. This is because, by their standards, incoming production activities are high skilled ones. This makes the wages of high- and low-skilled workers to diverge. According to Dinopoulos and Segerstrom (1999), instead, trade impacts on technological progress. It increases the reward for innovation, encouraging complex R&D activities both in developed and developing countries. This increases the demand for high skilled workers worldwide, boosting their relative wage with respect to low-skilled ones. Another example of model that revived the trade explanation for increasing inequality is Kurokawa (2011). According to this work, the link between trade and inequality passes through the increasing variety of goods demanded worldwide, which boosts the demand of high-skilled workers compared to low-skilled ones. Also Chusseau et al. (2008) agree that both trade and technological change have a role in explaining increasing wage inequality worldwide and they stress the importance of models assessing the impact of trade on endogenous technological change.

The connection between different energy sources and inequality has received more attention in policy oriented contributions than in quantitative economic studies. For instance, Sagar (2005) stresses that traditional energy sources badly affects the well-being of poor households in developing countries. A fund is proposed to help households to adapt to more modern energy carriers. Birol (2007) and Kaygusuz (2007) highlight the political relevance of energy poverty in developing countries. Recently, Srivastava and Sokona (2012) authoritatively brought again the issue to the attention of energy scholars and policy makers, collecting various contributions dealing with energy poverty in different parts of the world. General themes that emerge from these works are that solving the problem of energy access for poor households is a complex task. Often, public discourses and inadequate monitoring tools prevent a sufficient public awareness of the issues at stake. Developing countries should strive to find their own strategies, carefully considering their own needs, by involving local populations in decision processes. Key factors are not only building appropriate infrastructures, but also institutional frameworks that foster energy innovations, able to overcome the rural/urban electricity divides that often exist in developing countries. In order to put in place processes able to achieve all of these aims, government intervention is needed, not only in the form of institution building but also through public investments, while preserving financial stability. The importance of public-private partnerships should not be downplayed too.

Why energy poverty should be connected to income inequality though? This is for various reasons. In the first place traditional energy carriers damage the health of people, which naturally become less productive. Secondly, they are time consuming too. For instance, in developing countries, it is often the case that women have to spend a considerable amount of their time in finding wood and in bringing it home. Energy transition could free up time for other activities, both domestic and market ones. It could also yield direct revenues and employment in new energy sectors, as well as the birth of new firms.

In our view, all the above reasons warrant a quantitative study gauging the effects of globalization and the adoption of different energy sources on income inequality at the same time. Our method is the estimation of vector autoregression (VAR) models, as detailed below.

The rest of this paper is structured as follows. First we describe our dataset and data sources. Next we set out our results with respect to inequality, globalization and renewable energy sources. Then we perform a series of robustness checks, such as including other possible explanatory variables and considering other energy carriers. Finally, we conclude by contextualizing our results and the general considerations contained in the present Introduction within the Argentinean energy system. Therefore, we do not neglect that each country needs to follow its own path to energy transition, as also stressed by Sokona et al. (2012). In the Appendix we provide further evidence that the variables under study are stationary.

Dataset description

We start by focusing on three variables, the GINI index, which is our measure of inequality; the percentage of electricity production from renewable sources excluding hydroelectric power (RENPERC); and the KOF index of economic globalization after Dreher et al. (2008). The GINI index and RENPERC comes from the World Economic Indicators of the World Bank. The KOF index of economic globalization takes into account not only long distance flows of capital, goods and services, but also information and perceptions arising through market exchanges. Detailed information on how it is computed is available at http://globalization.kof.ethz.ch/.

Note that three observations are missing for the GINI index in 1988, 1989 and 1990. Therefore our baseline estimates will be based on observations from 1991 to 2010. However, one of our robustness checks will be to control that our results are not affected once using linear interpolation to fill the gap in the sample, so extending it from 1986 to 2010.

In our robustness checks we consider further variables. We add to the model domestic credit provided by the banking sector as percentage of GDP (PRIVATEBAN) and domestic credit to the private sector as percentage of GDP (PRIVATE). We insert these variables in our model one at a time. This is because Beck et al. (2007) found that financial development, measured in a similar way as above, can reduce inequality in a cross-country panel data study.

Next we try to substitute RENPERC respectively with the percentage of electricity production from hydroelectric sources (HYDROPERC), from nuclear sources (NUCLEARPERC) and from oil, gas and coal sources (FOSSILPERC). This is to check whether our results hold also when considering other energy carriers. PRIVATEBAN, PRIVATE, HYDROPERC, NUCLEARPERC and FOSSILPERC are all taken from the World Development Indicators. Table 1 offers a glossary of all the acronyms used in the present work. Note that in the rest of this paper when the acronym of a variable is preceded by an L, it means that it is considered in natural logs.

Table 2 shows descriptive statistics of our variables. As it is possible to see there is a good variability in the data, which is promising for our analysis. The next sections illustrate our results.

Results

We start by focusing on LGINI, LRENPERC, and LKOF. Our goal is, in the first place, to compute impulse response functions to detect the effect of LRENPERC and LKOF on LGINI and the possible counter-effects of the last variable on the first two. So we specify a VAR in levels.

Table 1 - Glossary of the acronyms

Acronyms	Explanation
GINI	GINI index
GINIPOL	Interpolated GINI index
RENPERC	Electricity production from renewable sources excluding hydroelectric power (% of total)
KOF	KOF index of economic globalization
PRIVATE	Natural log of domestic credit to private sector (% of GDP)
PRIVATEBAN	Natural log of domestic credit provided by banking sector as % of GDP
HYDROPERC	Electricity production from hydroelectric sources (% of total)
NUCLEARPERC	Electricity production from nuclear sources (% of total)
FOSSILPERC	Electricity production from oil, gas and coal sources (% of total)

Note: acronyms preceded by an L mark natural logarithms of the relevant variables.

Table 2 - Descriptive statistics

Acronyms	Observations	Mean	Std. Dev.	Maximum	Minimum
GINI	22	48.34	3.18	54.72	42.79
GINIPOL	25	48.05	3.08	54.72	42.79
RENPERC	25	0.92	0.86	2.96	0.17
KOF	25	49.61	6.95	57.96	38.98
PRIVATE	25	18.16	6.23	39.72	10.49
PRIVATEBAN	25	35.89	13.22	80.06	22.48
HYDROPERC	25	34.35	5.95	43.56	25.01
NUCLEARPERC	25	9.64	2.70	14.46	5.72
FOSSILPERC	25	55.08	6.95	66.64	43.13

In order to decide how many lags to insert we rely on lag order selection criteria. The sequential modified likelihood ratio (LR) statistic, the final prediction error, the Akaike, the Schwarz and the Hannan-Quinn information criteria all point to one lag. We run a lag exclusion Wald test, which strongly rejects the null that the first lag in levels of all variables should be dropped with p-values of order of 0.00.

Also block exogeneity Wald tests support our model given that for all the three equations the null that regressors should be dropped is rejected with p-values smaller than 0.01. On the basis of residuals inspection we insert three dummy variables for the years 1996, 2002 and 2006 respectively. In so doing we try to deal with possible structural breaks in the data[2]. It is worth noting that 2002 was the year of the peso crisis. 1996 and 2006 are the years in which electricity generation from renewable sources respectively took off and peaked.

We focus on the residuals of our model by running serial correlation, normality and heteroskedasticity tests. The Portmanteau test for autocorrelation with the presence of two lags of the variables under study accepts the null of no serial correlation with a p-value of 0.33. The same does the Lagrange Multiplier (LM) tests with one and two lags with p-values of respectively 0.12 and 0.65. Residuals appear to be normally distributed as the Jarque-Bera test does not reject the null of normality with a p-value of 0.75. The null of no heteroskedasticity is not rejected with a p-value of 0.53. So residuals of the VAR(1) model are well behaved.

The roots of the system points to stability being all less than one in modulus: two of them are equal to 0.96 and the other to 0.48. The stability of the system is confirmed by running Kwiatkowski, Phillips, Schmidt and Shin (1992) tests as showed by Table 3.[3]

Table 3 - Kwiatkowski, Phillips, Schmidt and Shin (1992) tests for stationarity for variables in logs.

		LGINI	LKOF	LRENPERC
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.231816	0.286258	0.111166
Asymptotic critical values*:	**1% level**	0.739000	0.739000	0.216000
	5% level	0.463000	0.463000	0.146000
	10% level	0.347000	0.347000	0.119000
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)				

Note: for all the variables we used a Newey-West automatic bandwidth and a Bartlett Kernel. Exogenous terms include only the constant for LGINI and LKOF and the constant and a linear trend for LRENPERC. Asymptotic critical values were taken from Table 1 of Kwiatkowski, Phillips, Schmidt and Shin (1992).

We included a time trend in the testing model for LRENPERC. This choice was comforted by econometric testing. The p-values of the time trend in the testing models for LGINI and LKOF were both greater than 0.05, being respectively equal to 0.16 and 0.051. Furthermore, we run a number of panel unit root tests on the residuals of the VAR(1) in levels with the three dummies above. The Levin, Lin and Chu

[2] Looking for structural breaks in variable coefficients seems prohibitive given the sample size.
[3] Recall that further evidence concerning the stationarity of variables is provided in the Appendix.

test, the Im, Pesaran and Shin test, the ADF - Fisher Chi-square test and the PP - Fisher Chi square test all strongly reject the presence of unit roots in the residuals with p-values of the order of 0.00[4].

Further note that the R^2 of the LGINI equation is equal to 0.85, the one of the LRENPERC equation to 0.99 and the one of the LKOF equation to 0.92. Adjusted R^2 respectively are 0.77, 0.99 and 0.88. The high percentage of explained variance downplays the risk of omission of relevant variables. Finally, we tried to insert a time trend in the VAR because we did so in testing for stationarity of LRENPERC. For all the three equations its coefficients were never statistically different from zero. So we preferred the specification without the time trend[5].

On the basis of the above evidence we feel confident in estimating impulse response functions. Results are displayed in Figures 1 and 2[6]. As it is possible to see, LGINI does not appear to have either statistically or economically significant effects on LRENPERC and LKOF, while an increase in economic globalization and in the percentage of electricity produced by renewable sources respectively increases and decreases inequality, as measured by the log of the GINI coefficient[7]. Considering only the LGINI equation, the short run elasticity of LGINI with respect to LRENPERC is 0.01, while with respect to LKOF is 0.24. Long-run elasticities respectively are 0.02 and 0.45. Given the above results we will not consider any more the possible counter-effects of inequality on other variables in the rest of the paper.

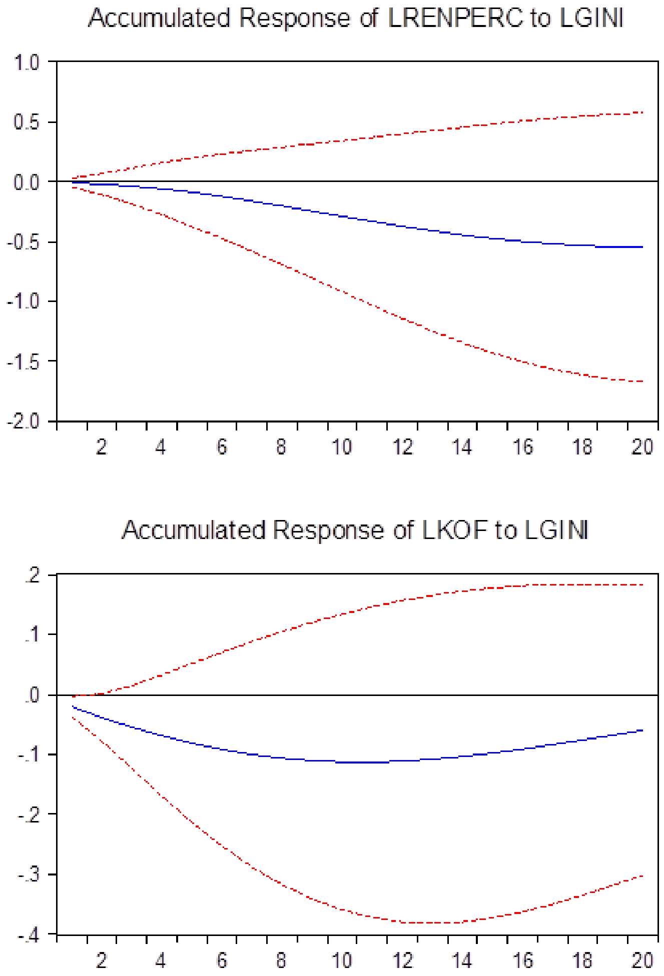
[4] We used the SIC criterion to select lag length and the the Newey - West automatic bandwidth using the Bartlett kernel where appropriate.

[5] T-statistics were equal to 0.33404, -0.99180 and -0.62839 for the LGINI, the LKOF and the LRENPERC respectively.

[6] In all the impulse response functions displayed in this paper, we show only a limited amount of periods, the reason being that we focus on time periods where the effect of impulses is statistically different from zero.

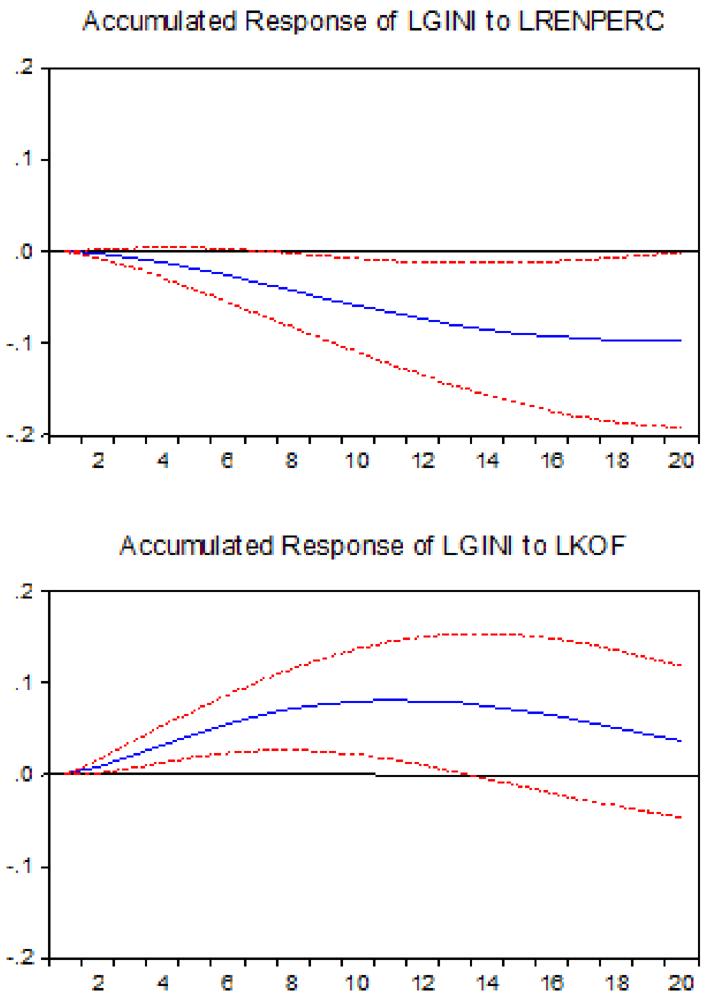
[7] Note that our results would not change once using interpolation to fill the missing values in the GINI coefficients and so extending our sample of reference. We preferred to be conservative and to rely on the smaller sample.

Figure 1 - Accumulated response functions to Cholesky one standard deviations



Note: dotted lines denote impulse responses plus and minus their standard errors.

Figure 2 - Accumulated response functions to Cholesky one standard deviations



Note: dotted lines denote impulse responses plus and minus their standard errors.

Robustness checks

Variables in levels

Our first robustness check is considering a different functional specification, namely we do not apply the log transformation to our data. We estimate a VAR in GINI, RENPERC and KOF. On the basis of residuals inspection we insert three dummies: for the years 2001, 2002 and 2006 respectively. Most of the above results are confirmed. Roots are within the unit circle, being the greatest equal to 0.82 and the smallest to 0.03. The stability of the system is again supported by the Kwiatkowski, Phillips, Schmidt and Shin (1992) tests as documented in Table 4.

Table 4 - Kwiatkowski, Phillips, Schmidt and Shin (1992) tests for stationarity for variables in levels

		GINI	KOF	RENPERC
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.273557	0.273558	0.128845
Asymptotic critical values*:	**1% level**	0.739000	0.739000	0.216000
	5% level	0.463000	0.463000	0.146000
	10% level	0.347000	0.347000	0.119000
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)				

Note: for LGINI and LKOF we used a Newey-West automatic bandwidth and a Bartlett Kernel. The only exogenous term is a constant. For LRENPERC we used a Newey-West automatic bandwidth and a Parzen Kernel. Exogenous terms include a constant and a linear trend. Asymptotic critical values were taken from Table 1 of Kwiatkowski, Phillips, Schmidt and Shin (1992).

The sequential modified LR statistic points to one lag length, but all the other lag length criteria - the final prediction error, the Akaike, the Schwarz and the Hannan-Quinn information criteria - point to two. We run a lag exclusion Wald test, which strongly rejects the null that both the first and second lags of all variables should be dropped with p-values of order of 0.00. Therefore we prefer a VAR(2) model in this case.

The Portmanteau test for autocorrelation with the presence of three lags of the variables under study accepts the null of no serial correlation with a p-value of 0.09. The same does the LM tests with one, two and three lags with p-values of respectively 0.10, 0.79 and 0.33. Residuals appear to be normally distributed as the Jarque-Bera test does not reject the null of normality with a p-value of 0.39. The null of no heteroskedasticity is not rejected with a p-value of 0.19. So residuals of the VAR(2) model are well behaved.

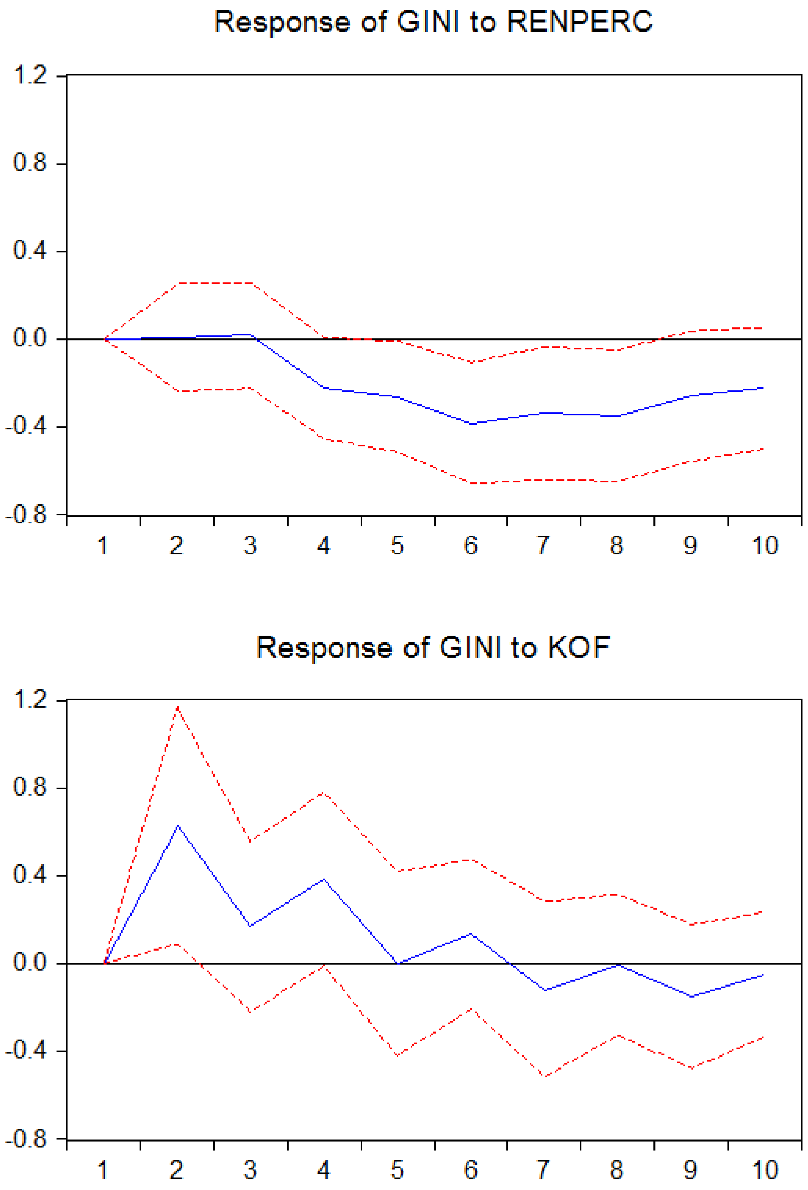
Once again panel unit root tests on the residuals of the VAR(2) in levels support the model. The Levin, Lin and Chu test, the Im, Pesaran and Shin test, the ADF - Fisher Chi-square test and the PP - Fisher Chi square test all strongly reject the presence of unit root in the residuals with p-values of the order of 0.00[8].

We try to use a different definition of impulse response functions, now considering responses to non-factorized one unit innovations as displayed in Figure 3. Once again an increase in the percentage of

[8] Again we used the SIC criterion to select lag length and the Newey - West automatic bandwidth using the Bartlett kernel where appropriate.

electricity produced by renewable energy sources significantly decreases inequality and the opposite happens for globalization.

Figure 3 - Responses to non-factorized one unit innovations

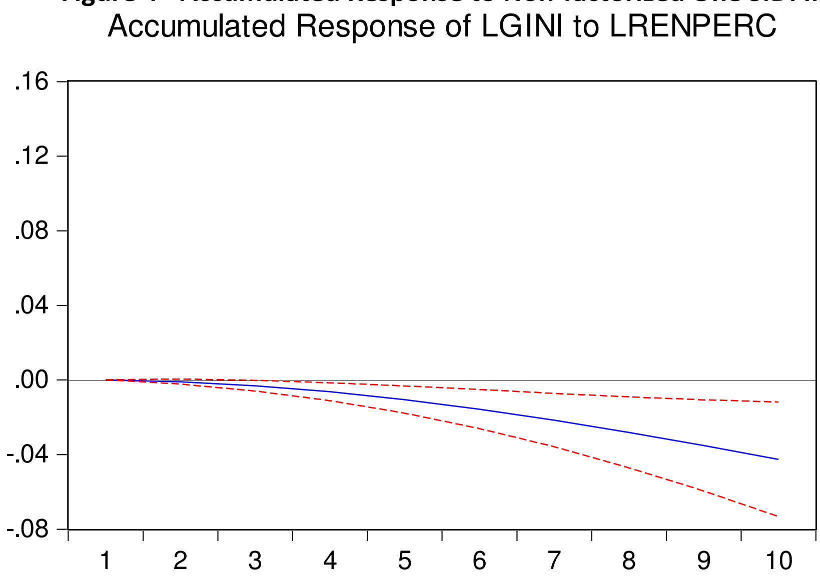


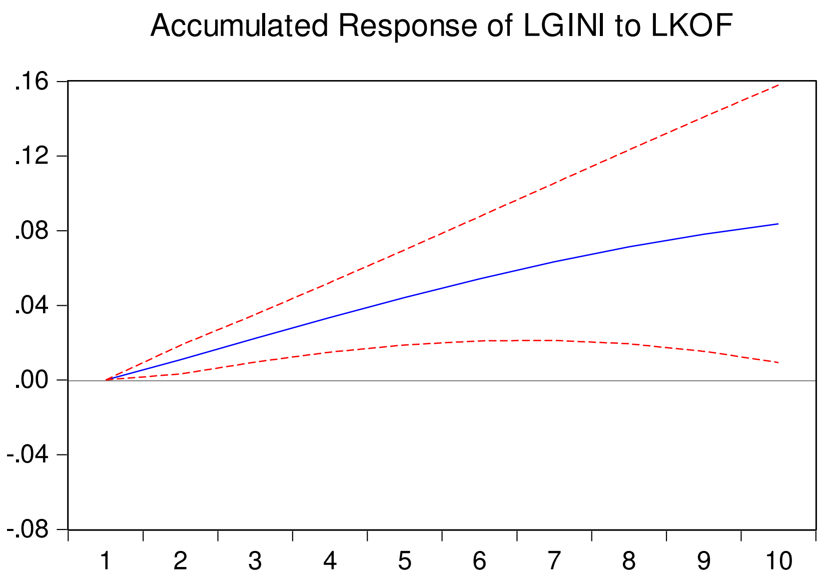
Note: dotted lines denote impulse responses plus and minus their standard errors.

Adding indicators of financial development

Our next robustness check consists in adding indicators of financial development, customarily used in the finance-growth literature and that Beck et al. (2007) found to reduce inequality. We start with LPRIVATEBAN. We do so by sticking to our baseline estimates. All tests would support the model, but the block exogeneity Wald test which returns a p-value of 0.24 for the LPRIVATEBAN equation. Therefore we specify the model in a different way. We drop the bespoken equation and we insert the first lag of LPRIVATEBAN as an exogenous regressor in a VAR(1) of LGINI, LRENPERC and LKOF.

Figure 4 - Accumulated Response to Non-factorized One S.D. Innovations ± 2 S.E.





Note: dotted lines denote impulse responses plus and minus their standard errors.

Block exogeneity tests now report p-values smaller than 0.05 for all the equations. Roots are within the unit circle, being the greatest two equal to 0.98 and the smallest one to 0.05. All length criteria prefer a value of 1. The null that this lag is equal to zero is again rejected with a p-value of 0.00. The presence of serial correlation is rejected by the Portmanteau test for autocorrelation with the presence of two and three lags, being p-values respectively equal to 0.40 and 0.67. LM tests with one, two and three lags report p-values of respectively 0.12, 0.81 and 0.95. Normality is not rejected as the Jarque-Bera estimator has a p-value of 0.98. The heteroskedasticity test returns a p-value of 0.27.

For robustness sake we choose for the present case, yet a different definition of impulse response function, namely the accumulated response to non-factorized one standard deviation innovations. Figure 4 shows that increasing LKOF increases LGINI, while increasing LRENPERC decreases LGINI. The effect of LPRIVATEBAN does not turn out to be statistically significant, as all its coefficients in the three VAR equations do not display p-values smaller than 0.05.

Suppose to consider instead variables in levels, without the log transformation. We estimate a VAR involving the variables GINIPOL, KOF, RENPERC and PRIVATE. Once again a block exogeneity test leads to drop the equation for PRIVATE, whose first lag is then included among exogenous variables. All lag length criteria point to 1 lag as the most suitable specification. Both the Portmanteau and the LM tests for autocorrelation find hardly any evidence of serial correlation. The former returns a p-value of 0.873 with 2 lags and the latter of 0.86 with one lag. Therefore we stick to a VAR(1). The Jarque-Bera test returns a p-value of 0.07 supporting normality and the residual heteroskedasticity term a p-value of 0.59, not rejecting the null of absence of heteroskedasticity.

Roots are within the unit circle as two of them are in modulus equal to 0.87 and the other one to 0.46. Variables appear to be stationary according to the Kwiatkowski, Phillips, and Schmidt and Shin (1992) test as showed in Table 5. Once again the panel unit root tests mentioned above do not find any evidence of unit roots, all returning p-values of 0.00 once applied to the residuals of the three equations of the VAR under study.

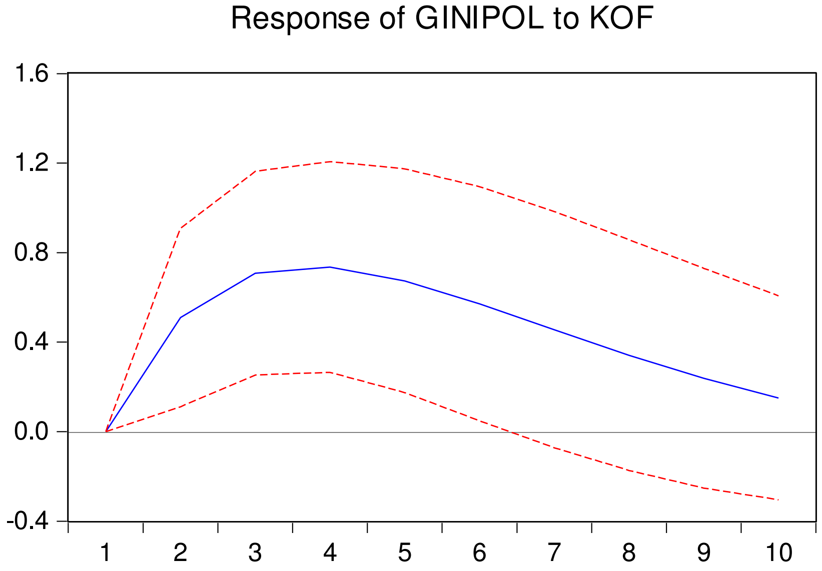
PRIVATE is not statistically significant in any of the VAR equations, so it can be dropped. Once moving to inspect responses to Cholesky one standard deviations innovations we find once again that inequality is positively connected to economic globalization and negatively to renewable energy electricity generation as percentage of total generation (Figure 5). We next move on to consider whether it is possible to find similar results to those above for other energy sources.

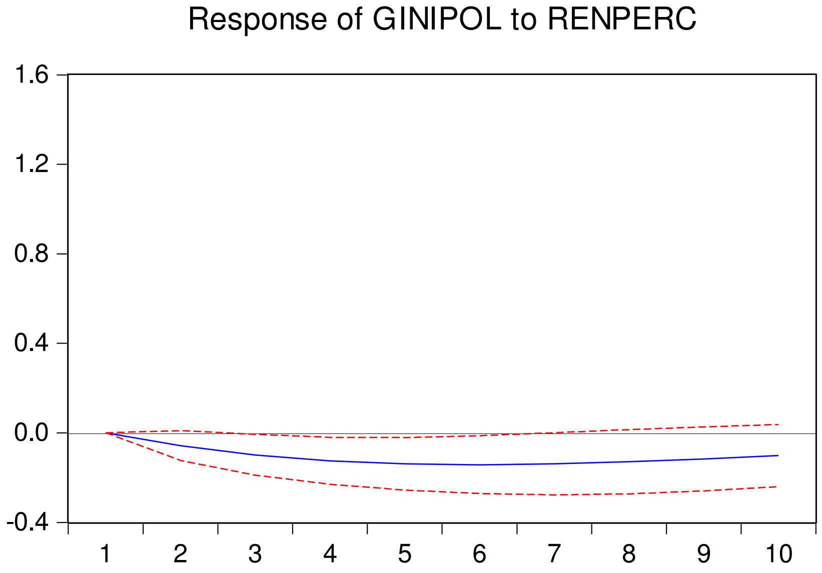
Table 5 - Kwiatkowski, Phillips, Schmidt and Shin (1992) tests for stationarity for variables in levels

			GINIPOL	KOF	RENPERC	PRIVATE
Kwiatkowski-Phillips-Schmidt-Shin test statistic			0.212311	0.196445	0.422081	0.326845
Asymptotic critical values*:		**1% level**	0.739000	0.739000	0.739000	0.739000
		5% level	0.463000	0.463000	0.463000	0.463000
		10% level	0.347000	0.347000	0.347000	0.347000
*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)						

Note: for all variables we used a Newey-West automatic bandwidth and a Parzen Kernel. The only exogenous term is a constant. Asymptotic critical values were taken from Table 1 of Kwiatkowski, Phillips, Schmidt and Shin (1992).

Figure 5 - Response to Cholesky one standard deviation innovation





Note: dotted lines denote impulse responses plus and minus their standard errors.

Other energy sources

First we start with hydroelectric power, then we move on to nuclear energy and finally we consider fossil sources. We first start to test for the stationarity of HYDROPERC, FOSSILPERC and NUCLEARPERC. Kwiatkowski, Phillips, Schmidt and Shin (1992) tests accept the null at least at the 5% level for all the variables under analysis (Table 6).

Table 6 - Kwiatkowski, Phillips, Schmidt and Shin (1992) tests for stationarity for variables in levels

		HYDROPERC	FOSSILPERC	NUCLEARPERC
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.252860	0.116454	0.427933
Asymptotic critical values*:	**1% level**	0.739000	0.216000	0.739000
	5% level	0.463000	0.146000	0.463000
	10% level	0.347000	0.119000	0.347000

Note: for all variables we used a Newey-West automatic bandwidth and a Parzen Kernel. The only exogenous term is a constant, with the exception of FOSSILPERC where a trend was inserted on the basis of its statistical significance in the model underlying the stationarity test. Asymptotic critical values were taken from Table 1 of Kwiatkowski, Phillips, Schmidt and Shin (1992).

Hydroelectric generation

We estimate a VAR with GINI, HYDROPERC and KOF. We start with a VAR(1) model, which all tests on residuals, stationarity and lag length would support. However, block exclusion Wald tests return a p-value of 0.00 for the GINI equation, one of 0.81 for the HYDROPERC equation and one of 0.07 for the KOF equation. Therefore we re-specify the model considering the first lag of HYDROPERC as an exogenous variable. The block exclusion Wald test of the KOF equation still returns a p-value of 0.98.

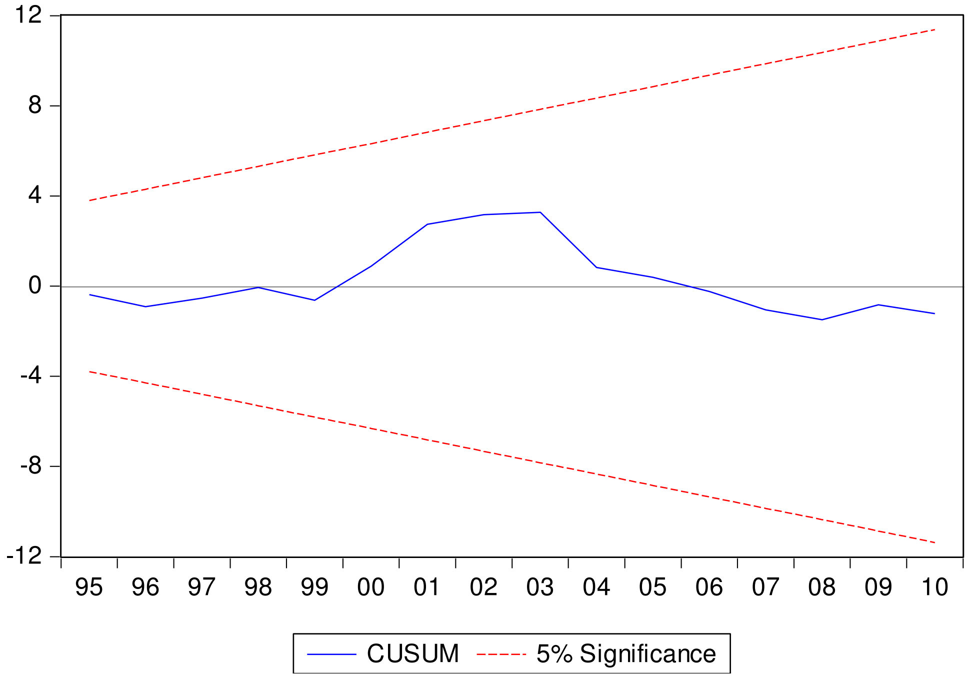
Therefore we regressed GINI on a constant its first lag, and the first lags of KOF and HYDROPERC. We used White heteroskedasticity consistent standard errors. The Breusch-Godfrey serial correlation LM test with 2 and 14 degrees of freedom reports a p-value of 0.29. Therefore we do not insert further lags of variables in the model. The Jarque-Bera normality test for the residuals displays a p-value of 0.85. The RESET test does not find evidence of omitted variables - as inserting the square of the fitted values of the model, it returns a p-value of 0.16. The CUSUM and CUSUM of squares considering all coefficients do not detect any presence of structural breaks as showed by Figure 6.

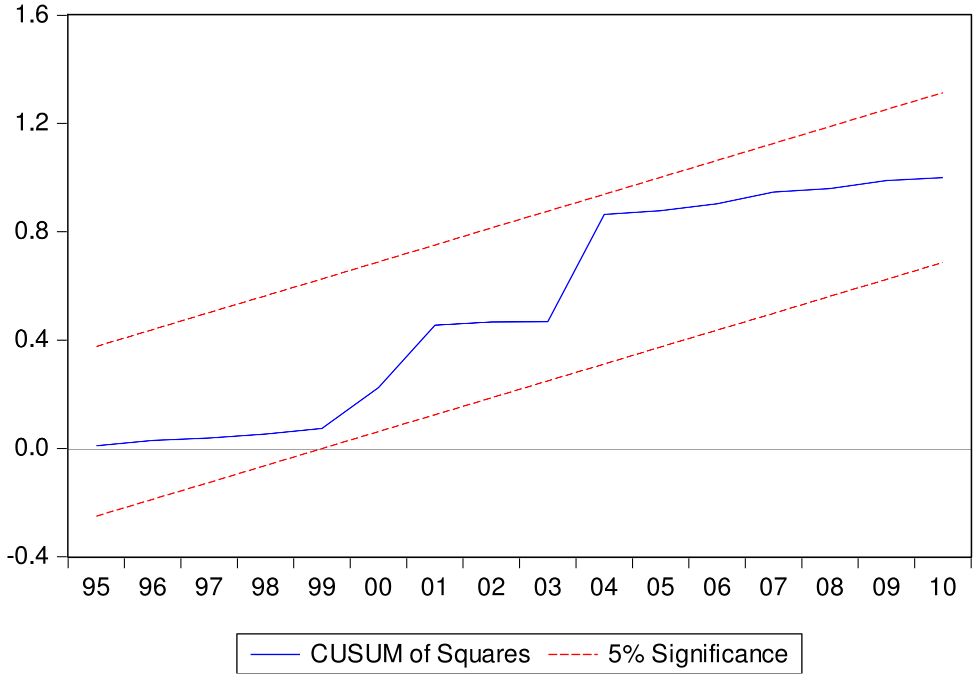
In brief our estimated model is

$$\underset{(0.24)}{GINI = 8.97} + \underset{(0.04)}{0.19}*KOF(-1) + \underset{(0.04)}{0.12}*HYDROPERC(-1) + \underset{(0.02)}{0.53}*GINI(-1) + u_t \qquad (1)$$

where p-values are reported in parentheses and u_t is a stochastic error. This model has a R^2 of 0.83 and an adjusted-R^2 of 0.80. The above coefficient estimates imply short-run elasticities at mean values equal to 0.20 and 0.08 for KOF and HYDROPERC respectively. Respective long-run elasticities are 0.42 and 0.17.

Figure 6 - Structural breaks test for equation 1.





Nuclear electricity generation

We estimate a VAR with GINI, NUCLEARPERC and KOF. All tests would support a VAR(1) model. However Wald block exogeneity tests lead to specify a single equation as happened for HYDROPERC.

GINI was regressed on a constant, its first lag, and the first lags of KOF and HYDROPERC, by using White heteroskedasticity consistent standard errors. No serial correlation was detected by the Breusch-Godfrey test with 2 and 14 degrees of freedom, which reported a p-value of 0.40. No further lags were inserted therefore in the model. Normality was not rejected by the Jarque-Bera test displaying a p-value of 0.54. The square of the fitted values, once inserted in the model, has a p-value of 0.16, not letting to suppose the omission of any relevant variable. No structural break was detected by the CUSUM and the CUSUM of squares tests as showed by Figure 7.

Our estimated model, with p-value in parentheses, is

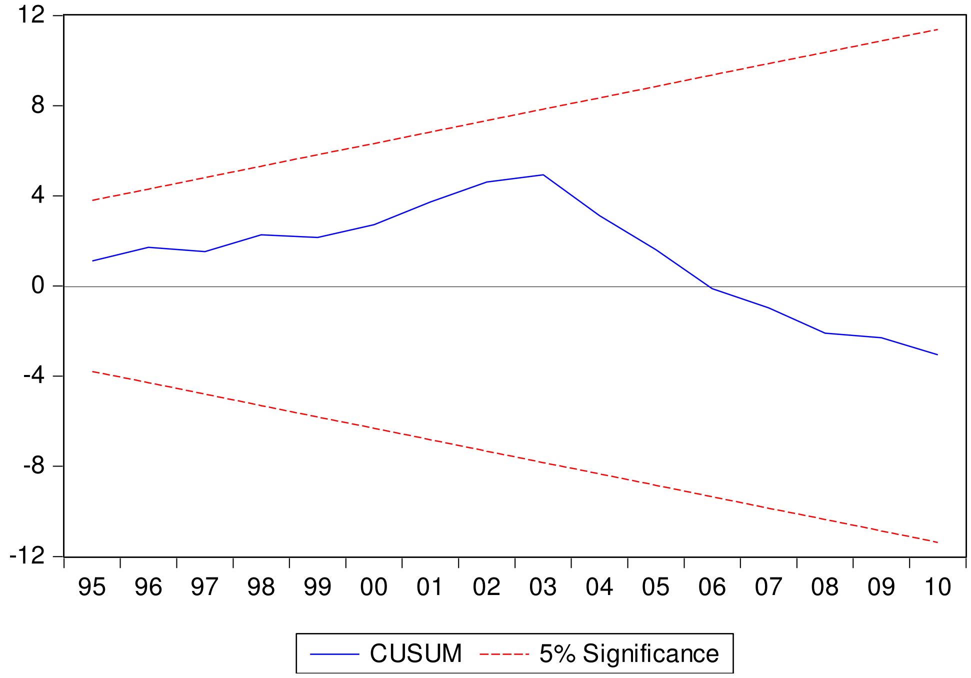
$$\underset{(0.28)}{\text{GINI} = 10.61} + \underset{(0.04)}{0.19^*\text{KOF}(-1)} + \underset{(0.56)}{0.06^*\text{NUCLEARPERC}(-1)} + \underset{(0.04)}{0.56^*\text{GINI}(-1)} + e_t \qquad (2)$$

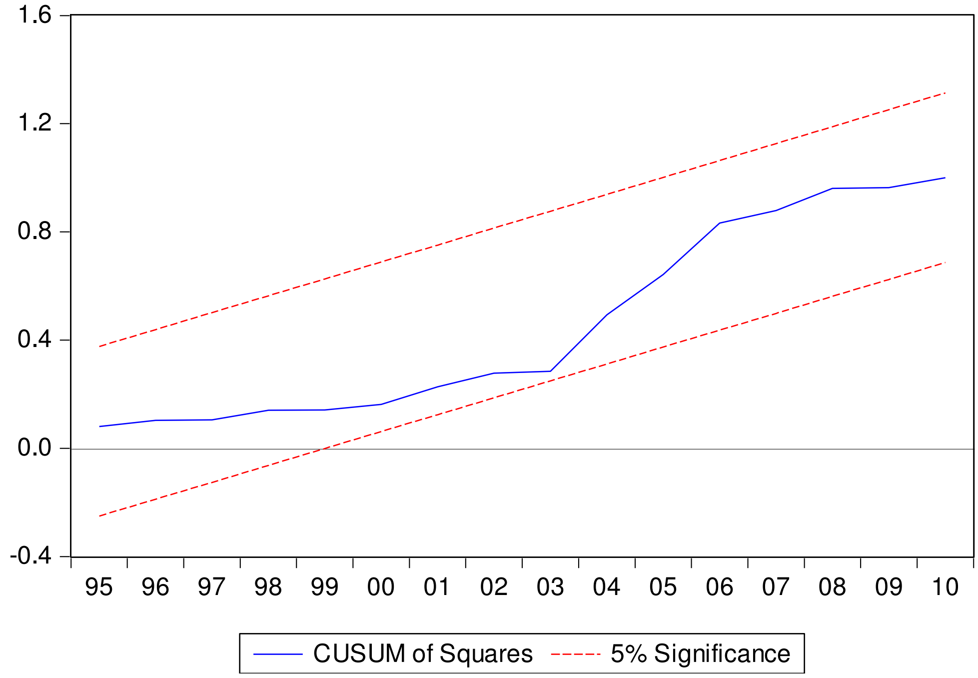
where e_t is a stochastic error. The R^2 and the adjusted-R^2 respectively are 0.78 and 0.74. NUCLEARPERC does not appear to have any significant impact on inequality.

Fossil electricity generation

We estimate a VAR with GINI, FOSSILPERC and KOF. We include a trend because we did so in the stationarity test for FOSSILPERC. As with HYDROPERC and NUCLEARPERC block exogeneity tests would lead to specify a single equation for GINI. We proceeded as before, performing a regression of GINI on a constant, the first lags of GINI, KOF and FOSSILPERC with White heteroskedasticity consistent standard errors. No serial correlation was detected as the Breusch-Godfrey test with 2 and 14 degrees of freedom reported a p-value of 0.28. Figure 8 shows the absence of structural breaks. The null of normality was accepted with a p-value of 0.82. The square of the fitted values, once inserted in the model, has a p-value of 0.22. FOSSILPERC had a statistically insignificant coefficient of -0.09 with a p-value of 0.09. The other coefficients and p-values, as well as the R^2 and the adjusted-R^2 were of the same order of magnitude as in the two models above. Including a trend in the model would produce a insignificant coefficient of -0.03 with a p-value of 0.47.[9]

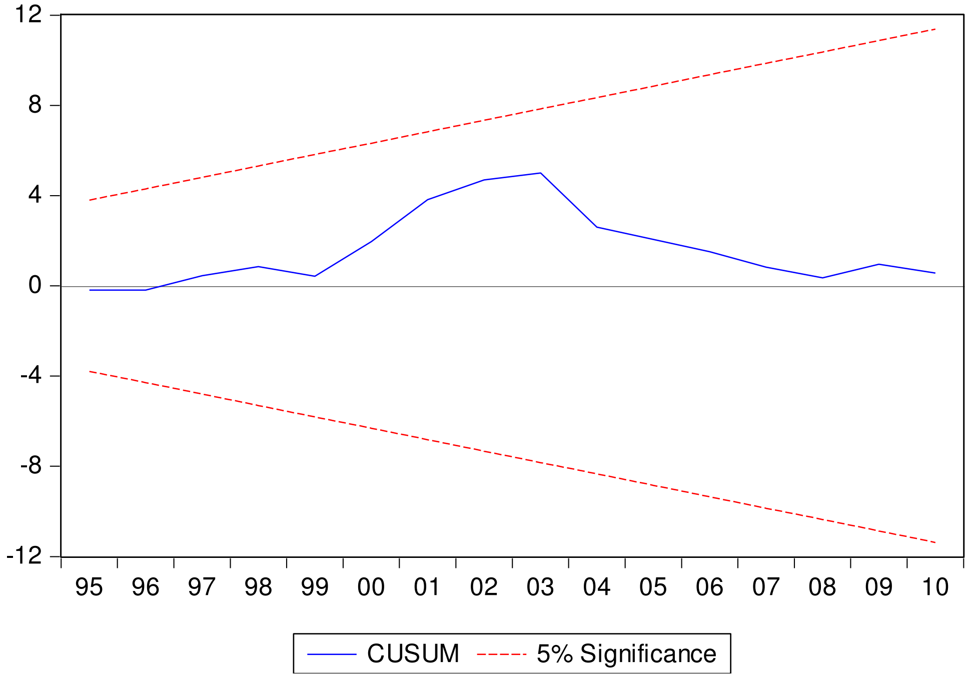
Figure 7 - Structural breaks test for equation (2)

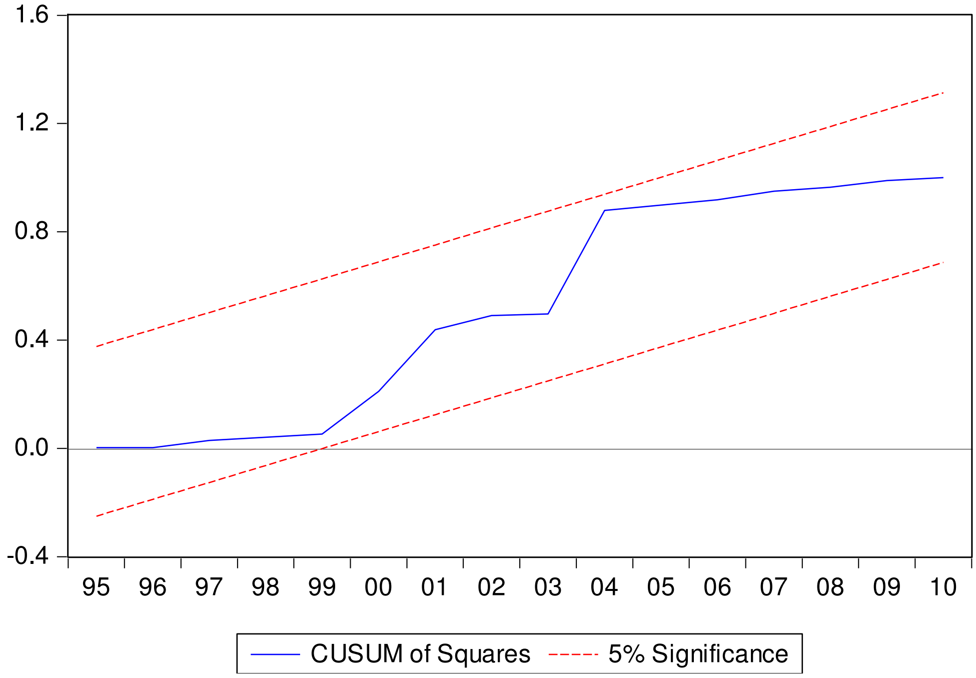




[9] As a final robustness check suppose to insert LHYDROPERC, LNUCLEARPERC and LFOSSILPERC in our baseline VAR. They would never have significant coefficient in any model. More details are available from the author upon request.

Figure 8 - Structural breaks test for the model including FOSSILPERC





Conclusions and implications for energy policy in Argentina

In brief, our results are that in Argentina globalization and hydroelectric power increase inequality while other renewable energy sources decrease it. Further energy sources do not affect inequality. The effect of globalization is larger than those of energy sources. This means that there should be a considerable increase in renewable energy generation (excluding hydroelectric power) to offset the consequences of globalization on income inequality.

Regarding the result on globalization, we cannot offer a test for the various mechanisms the literature proposed to explain the effect of globalization on inequality, because our index is a catch all variable. However, we can confirm that in general globalization increases inequality, which is important because this means that in our case the effect microeconomic mechanisms also show up once considering econometric tests on macroeconomic magnitudes.[10]

Concerning hydroelectric power, one needs to remember that hydroelectric power is generated by large dams in Argentina (Guzowski and Recalde, 2010, p. 5815). This kind of infrastructure has often been very controversial. They have not only benefits, but also high environmental and social costs for local communities. Flood control, water supply, low-cost energy and increased opportunities for recreation can be provided. Hydro power also reduces CO_2 emissions. However, large dams change a terrestrial ecosystem into an aquatic one, often displacing people from the area to be inundated (Koch, 2002; Frey and Linke, 2002; Magnani, 2012, 9-13). Under extreme circumstances they can be a challenge to the security of local communities, as the Frìas disaster in 1970 reminds us (see among others Singh, 1996, 85-86). What is more, this kind of facilities mainly serves urban centers, so they often offer little help in overcoming rural/urban divides (Lerer and Scudder, 1999). Therefore, it is not so surprising that hydropower generation by large dams can increase inequality once taking into account the considerations above.

Regarding the effect of other renewable energy sources on inequality one needs to carefully consider the Argentinean context. One first important thing to keep into account is that in Argentina, according to the US Energy Information Administration, other renewable energy sources for electricity

[10] For a similar point in a different field see Brown et al. (2009).

generation than hydroelectric power are wind (3%) and mostly biomass and waste (97%). As already noticed both account for a very small share of overall electricity generation. What is more, though this share tended to increase between 1994 and 2006, this trend was then reversed - especially for wind power, whose share dropped back to its early nineties level.

Many studies concerned with electricity issues in Argentina focus on market reforms. Before the 2002 peso crisis, the country experienced deep deregulation and privatization processes, which were later reversed. A price cap was even introduced. The relevant literature is divided, as some scholars claim that deregulation and privatization were appropriate policies, while others highlight the pitfall of these policies (see for instance Dutt et al., 1997; Pollit, 2008; Nagayama and Kashiwagi, 2007; Haselip, 2005; Haselip et al., 2005, Haselip and Potter, 2010; Guzowski and Recalde, 2010).

However, different energy sources are an important issue in itself though. This is because a country should not concentrate only on a single kind of renewable energy. On the contrary, diversification among different renewable energy sources can also help overcoming intermittency problems. Policies to foster renewable energy sources have been hampered so far by a large endowment of natural gas in Argentina (Guzowski and Recalde, 2008). At present policy intervention is based on quota systems and subsidies, however, according to some experts, these tools are less promising than feed-in tariffs, that were successfully adopted in Germany, Spain and the US, for instance (Guzowski and Recalde, 2010).

Wind energy has a great potential in Argentina, but installed capacity is tiny and mainly in small cooperative projects with the aim to supply rural local communities. Yet, this offers an example of the mechanisms highlighted in the introduction whereby renewable energy generation can reduce inequality. This notwithstanding current regulation and distorted prices put wind power at disadvantage and prevent Argentina to fully exploit the benefits that other countries already enjoy (Guzowski and Recalde, 2008; 2010; Recalde, 2010; Kaygusuz, 2004).

As successful countries in promoting renewable energy sources - such as Germany and Denmark - different forms of government intervention are needed in Argentina too (Guzowski and Recalde, 2008;

2010). They should be directed at building a clear regulatory framework; promoting long-term contracts and concessions to abate market risk; weaving national-international nets; supporting educational and information initiatives; and, finally, favoring the access to the credit market by providing some form of guarantees to entrepreneurs (Guzowski and Recalde, 2008; Larson and Kartha, 2000; Lawand and Ayoub, 1996). Many policy interventions of this kind were taken in Chile, for instance (Guzowski and Recalde, 2010). It is important to recall, though, that each single policy tool should be assessed within the overall policy framework in place in a given country or region and together with its interaction with technological progress and social factors (Fischer and Preonas, 2010; Escalante et al., 2013).

Finally, the advantages of renewable energy sources discussed in the introduction exist for biomass energy too. However, for this kind of energy, there exists a peculiar trade-off, namely the competition for land with the production of food. Furthermore, the increase in biomass energy generation is often achieved by ousting tenant farmers and appropriating common lands (Larson and Kartha, 2000). In the past, there was little attention to these issues. However, there exists ways to soften the bespoken trade-off thanks to technological advances in agricultural activities and with a better coordination of international, national and especially local institutions. The last ones and local population at large should have the chance to express and defend local needs. Methods to enable this have been studied in the literature (Muguerza et al., 1990; García-López and Arizpe, 2010). This is important for various reasons. It increases the chances of success for the various projects, which can better adapt to local complexities. Furthermore, it can also prevent deforestation and preserve local biodiversity (Larson and Williams, 1995; Larson and Kartha, 2000). The relevance of these issues should not be downplayed, because what is at stake is the possibility to assure not only the carbon-neutrality of biomass energy, but also the chance to make it carbon negative (Mathews and Goldsztein, 2009; Manrique et al, 2011). Moreover forests can be a source of energy in themselves, once using wood pellets and sawdust produced by the wood industry as energy generation inputs (Uasuf and Becker, 2011; Bandyopadhyay, 2011)[11]. Hopefully, international policy makers seem to be aware of the issues at stake, as testified by the PROBIOMASA FAO project.[12]

References

Andrews D. (1993) Exactly median unbiased estimation of first order autoregressive/unit root models, Econometrica 61, 139-165.

Andrews, D. and H.Y. Chen. 1994. Approximately Median Unbiased Estimation of Autoregressive Models. Journal of Business and Economic Statistics 12: 187-204

Apergis, N. and J. E. Payne. 2012. "A Global Perspective on the Renewable Energy Consumption-Growth Nexus", Energy Sources, Part B: Economics, Planning, and Policy, 7, 314-322.

Apergis, N. and J. E. Payne. 2013. "Another Look at the Electricity Consumption-Growth Nexus in South America", Energy Sources, Part B: Economics, Planning, and Policy, 8, 171-178

Bandyopadhyay Sushenjit, Priya Shyamsundar, Alessandro Baccini, Forests, biomass use and poverty in Malawi, Ecological Economics, Volume 70, Issue 12, 15 October 2011, Pages 2461-2471, ISSN 0921-8009, http://dx.doi.org/10.1016/j.ecolecon.2011.08.003.

Beck Thorsten & Asli Demirgüç-Kunt & Ross Levine, 2007. "Finance, inequality and the poor," Journal of Economic Growth, Springer, vol. 12(1), pages 27-49, March

Bilgen, S., Kaygusuz, K. and A. Sari. 2004 "Renewable Energy for a Clean and Sustainable Future", Energy Sources, 26, 12, 1119-1129.

Birol Fatih, 2007."Energy Economics: A Place for Energy Poverty in the Agenda?" The Energy Journal, International Association for Energy Economics, vol. 0(Number 3), pages 1-6.

[11] A series of specific proposals to improve the sustainability of the biomass industry in Argentina was advanced in Shafik et al. (2006).

[12] http://ccap.org/assets/Argentina_Renewable_Energy_Probiomassa_May_2013_NAMA_Executive_Summary.pdf

Brown, J. R., Steven M. Fazzari and Bruce C. Petersen, 2009. "Financing Innovation and Growth: Cash Flow, External Equity, and the 1990s R&D Boom." Journal of Finance 64: 151-185.

Bruns, Stephan B., Gross, Christian and Stern, David I., Is There Really Granger Causality between Energy Use and Output? (March 8, 2013). Crawford School Research Paper No. 13-07. Available at SSRN: http://ssrn.com/abstract=2232455 or http://dx.doi.org/10.2139/ssrn.2232455

Chontanawat, J., Hunt, L.C., Pierse, R., 2006. Causality between energy consumption and GDP: evidence from30 OECD and 78 non-OECD countries. Paper No. SEEDS 113. Surrey Energy Economics Discussion Paper Series. University of Surrey.

Chusseau, N., Dumont, M. and Hellier, J. (2008), EXPLAINING RISING INEQUALITY: SKILL-BIASED TECHNICAL CHANGE AND NORTH–SOUTH TRADE. Journal of Economic Surveys, 22: 409–457. doi: 10.1111/j.1467-6419.2007.00537.x

Crinò, Rosario (2009), Offshoring, Multinationals and Labour Market: A Review of the Empirical Literature, Journal of Economic Surveys, 2009, 23(2), pp. 197-249

Dinopoulos, Elias & Segerstrom, Paul, 1999. "The dynamic effects of contingent tariffs," Journal of International Economics, Elsevier, vol. 47(1), pages 191-222, February

Dreher, Axel, Noel Gaston and Pim Martens (2008), Measuring Globalisation – Gauging its Consequences (New York: Springer).

Dutt Gautam S., Fernando G. Nicchi, Mario Brugnoni, Power sector reforms in Argentina: an update, Energy for Sustainable Development, Volume 3, Issue 6, March 1997, Pages 36-54, ISSN 0973-0826, http://dx.doi.org/10.1016/S0973-0826(08)60219-7.

Escalante, K.N. & Belmonte, S. & Gea, M.D., 2013. "Determining factors in process of socio-technical adequacy of renewable energy in Andean Communities of Salta, Argentina," Renewable and Sustainable Energy Reviews, Elsevier, vol. 22(C), pages 275-288.

Fanelli, José María. 2002, "Growth, instability and the convertibility crisis in Argentina". CEPAL Review, 77, 25-43.

Feenstra, Robert C & Hanson, Gordon H, 1996. "Globalization, Outsourcing, and Wage Inequality," American Economic Review, American Economic Association, vol. 86(2), pages 240-45, May.

Fischer, C., Preonas, L., 2010. Combining policies for renewable energy. Discussion Paper 10-19. Resources for the future, Washington DC.

Frey, Gary W. and Deborah M. Linke (2002), Hydropower as a renewable and sustainable energy resource meeting global energy challenges in a reasonable way, Energy Policy 30, 1261–1265.

García-López Gustavo A., Nancy Arizpe, Participatory processes in the soy conflicts in Paraguay and Argentina, Ecological Economics, Volume 70, Issue 2, 15 December 2010, Pages 196-206, ISSN 0921-8009, http://dx.doi.org/10.1016/j.ecolecon.2010.06.013.

Groisman, Fernando, 2008. "Distributive effects during the expansionary phase in Argentina (2002-2007)". CEPAL Review, 96, 203-222.

Guzowski C., M. Recalde, Latin American electricity markets and renewable energy sources: The Argentinean and Chilean cases, International Journal of Hydrogen Energy, Volume 35, Issue 11, June 2010, Pages 5813-5817, ISSN 0360-3199, http://dx.doi.org/10.1016/j.ijhydene.2010.02.094.

Guzowski, C., M. Recalde, Renewable energy in Argentina: Energy policy analysis and perspectives, International Journal of Hydrogen Energy, Volume 33, Issue 13, July 2008, Pages 3592-3595, ISSN 0360-3199, http://dx.doi.org/10.1016/j.ijhydene.2007.11.032.

Haselip, J. A. (2005). Renegotiating Electricity Contracts after an Economic Crisis and Currency Devaluation: The Case of Argentina. The Electricity Journal, 18(3), 78-88 doi: 10.1016/j.tej.2005.03.003

Haselip, J. A., Dyner, I., & Cherni, J. (2005). Electricity market reform in Argentina: assessing the impact for the poor in Buenos Aires. Utilities Policy, 13(1), 1-14 doi: 10.1016/j.jup.2004.03.001

Haselip, James & Potter, Clive, 2010, "Post-neoliberal electricity market 're-reforms' in Argentina: Diverging from market prescriptions?," Energy Policy, Elsevier, vol. 38(2), pages 1168-1176, February.

Hayo Bernd and Matthias Neuenkirch (2013), Does the currency board matter? US news and Argentine financial market reaction, Applied Economics, 45, 4034-4040.

Herrera, Germán and Andrés Tavosnanska, 2011. "Argentine industry in the early twenty-first century (2003-2008)", CEPAL Review, 104, 99-117.

Kaygusuz Kamil (2004), Wind Energy: Progress and Potential, Energy Sources, 26, 95-105.

Kaygusuz, K., 2007. Energy for sustainable development: key issues and challenges. Energy Sources, Part B, 2, 73–83.

Koch, Frans H. (2002). Hydropower — the politics of water and energy: Introduction and overview, Energy Policy 30, 1207–1213.

Kurokawa Yoshinori, 2011. "Variety-skill complementarity: a simple resolution of the trade-wage inequality anomaly," Economic Theory, Springer, vol. 46(2), pages 297-325, February.

Kurokawa, Y. (2012), A Survey of Trade and Wage Inequality: Anomalies, Resolutions and New Trends. Journal of Economic Surveys. doi: 10.1111/joes.12007.

Kwiatkowski, D., P. C. B. Phillips, P. Schmidt, and Y. Shin (1992): Testing the Null Hypothesis of Stationarity against the Alternative of a Unit Root. Journal of Econometrics 54, 159–178.

Larson, E.D. and R.H. Williams. (1995). Biomass Plantation Energy Systems and Sustainable Development. In Energy as an Instrument for Socio-Economic Development, J. Goldemberg and T.B. Johansson, eds., 91-106, New York, United Nations Development Program.

Larson, Eric D. and Sivan Kartha, Expanding roles for modernized biomass energy, Energy for Sustainable Development, Volume 4, Issue 3, October 2000, Pages 15-25, ISSN 0973-0826, http://dx.doi.org/10.1016/S0973-0826(08)60250-1.

Lawand T.A., J. Ayoub, Renewable energy activities in rural Argentina — Educational aspects, Renewable Energy, Volume 9, Issues 1–4, September–December 1996, Pages 1194-1198, ISSN 0960-1481, http://dx.doi.org/10.1016/0960-1481(96)88491-6.

Lee, C.-C., 2005. Energy consumption and GDP in developing countries: a cointegrated panel analysis. Energy Economics 27 (3), 415–427.

Lee, C.-C., 2006. The causality relationship between energy consumption and GDP in G-11 countries revisited. Energy Policy 34, 1086–1093.

Lerer Leonard B, Thayer Scudder, Health impacts of large dams, Environmental Impact Assessment Review, Volume 19, Issue 2, March 1999, Pages 113-123, ISSN 0195-9255, http://dx.doi.org/10.1016/S0195-9255(98)00041-9.

Magnani Natalia 2012, The Green Energy Transition. Sustainable Development or Ecological Modernization? "Sociologica", 2, 1-25, http://www.sociologica.mulino.it/doi/10.2383/38270.

Manrique Silvina, Judith Franco, Virgilio Núñez, Lucas Seghezzo, Potential of native forests for the mitigation of greenhouse gases in Salta, Argentina, Biomass and Bioenergy, Volume 35, Issue 5, May 2011, Pages 2184-2193, ISSN 0961-9534, http://dx.doi.org/10.1016/j.biombioe.2011.02.029.

Mathews John A., Hugo Goldsztein, Capturing latecomer advantages in the adoption of biofuels: The case of Argentina, Energy Policy, Volume 37, Issue 1, January 2009, Pages 326-337, ISSN 0301-4215, http://dx.doi.org/10.1016/j.enpol.2008.07.022.

Muguerza Daniel, Daniel Bouille, Erik Barney, A method for the appraisal of alternative electricity supply options applied to the rural areas of Misiones Province, Argentina, World Development, Volume 18, Issue 4, April 1990, Pages 591-604, ISSN 0305-750X, http://dx.doi.org/10.1016/0305-750X(90)90074-8.

Nagayama Hiroaki, Takeshi Kashiwagi, Evaluating electricity sector reforms in Argentina: lessons for developing countries?, Journal of Cleaner Production, Volume 15, Issue 2, 2007, Pages 115-130, ISSN 0959-6526, http://dx.doi.org/10.1016/j.jclepro.2005.11.056.

Orcutt G. H. and Winokur H.S. (1969) First order autoregressions: inference, estimation and prediction, Econometrica 37, 1-14.

Payne, J. E., 2009. On the dynamics of energy consumption and output in the US, Applied Energy, Volume 86, Issue 4, Pages 575-577.

Payne, J.E., 2010a. Survey of the international evidence on the causal relationship between energy consumption and growth. Journal of Economic Studies 37, 53–95.

Payne, J.E., 2010b. A survey of the electricity consumption-growth literature. Applied Energy 87, 723–731.

Pollitt Michael, Electricity reform in Argentina: Lessons for developing countries, Energy Economics, Volume 30, Issue 4, July 2008, Pages 1536-1567, ISSN 0140-9883, http://dx.doi.org/10.1016/j.eneco.2007.12.012.

Quenouille M. H. (1956) Notes on bias estimation, Biometrika 43, 353-360.

Recalde, M., Wind power in Argentina: Policy instruments and economic feasibility, International Journal of Hydrogen Energy, Volume 35, Issue 11, June 2010, Pages 5908-5913, ISSN 0360-3199, http://dx.doi.org/10.1016/j.ijhydene.2009.12.114.

Sagar Ambuj D., Alleviating energy poverty for the world's poor, Energy Policy, Volume 33, Issue 11, July 2005, Pages 1367-1372, ISSN 0301-4215, http://dx.doi.org/10.1016/j.enpol.2004.01.001.

Shafik Asal, Rémi Marcus, Jorge A. Hilbert, Opportunities for and obstacles to sustainable biodiesel production in Argentina, Energy for Sustainable Development, Volume 10, Issue 2, June 2006, Pages 48-58, ISSN 0973-0826, http://dx.doi.org/10.1016/S0973-0826(08)60531-1.

Singh, V.P. (1996), Dam Breach Modeling Technology, Kluwer Academic Publishers, Dordrecht, The Netherlands.

Sokona Youba, Yacob Mulugetta, Haruna Gujba, Widening energy access in Africa: Towards energy transition, Energy Policy, Volume 47, Supplement 1, June 2012, Pages 3-10, ISSN 0301-4215, http://dx.doi.org/10.1016/j.enpol.2012.03.040.

Srivastava Leena and Youba Sokona, eds. (2012), Universal access to energy: Getting the framework right, Energy Policy 47, Supplement 1, 1-94.

Uasuf Augusto, Gero Becker, Wood pellets production costs and energy consumption under different framework conditions in Northeast Argentina, Biomass and Bioenergy, Volume 35, Issue 3, March 2011, Pages 1357-1366, ISSN 0961-9534, http://dx.doi.org/10.1016/j.biombioe.2010.12.029.

Yoo, S.-H., 2006. The causal relationship between electricity consumption and economic growth in the ASEAN countries. Energy Policy 34 (18), 3573–3582.

Appendix

The present appendix shows further results confirming the stationarity of the series analysed in this study. OLS estimates of autoregressive parameters in autoregressive models are well known to be biased (see for example Orcutt and Winokur, 1969 or Quenouille, 1956). We show here that our results are robust to adopting the exactly median unbiased (EMU) estimator proposed by Andrews (1993) for autoregressive models of order 1. We do not need to resort to the Andrews and Chen (1994) estimator for autoregressive processes of higher order, because both the Schwarz and the Hannan-Quinn information criteria point to one lag as the most suitable specification for all the variables we considered[13].

[13] Further details are available from the author upon request.