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Erasmo Escala 1835
Teléfono: (56) 22 8897356
Casilla 14446 - Correo 21 - Santiago
Chile

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ECONOMIC ANALYSIS
R E V I E W

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THE YIELD CURVE INFORMATION UNDER UNCONVENTIONAL MONETARY POLICIES*

LA INFORMACION EN LA ESTRUCTURA DE TASAS BAJO POLITICAS MONETARIAS NO CONVENCIONALES

LUIS CEBALLOS**
Central Bank of Chile

DAMIAN ROMERO***
Central Bank of Chile and Barcelona Graduate School of Economics

Abstract

This paper attempts to address the question of how unconventional monetary policies affected the market expectations regards the expected path of the monetary policy rate and economic growth in countries where some kind of unconventional monetary policies were applied. The approach used is to compare the implicit expectations in the yield curve with market surveys (for the expected path pf monetary policy rate) and econometric models (for economic growth) and evaluate the accuracy of each forecast at different horizons. We conclude that in the period where unconventional monetary policies were applied, the yield curve provided relevant additional information to forecast the monetary policy rate and economic growth, especially in developed economies.

Keywords: *Yield curve, unconventional monetary policies, economic forecasting.*

JEL Classification: *E43, E44, E47, E58.*

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** Central Bank of Chile, Agustinas 1180, Santiago, Chile. E-mail: lceballos@bcentral.cl

*** Central Bank of Chile and Barcelona Graduate School of Economics.
E-mail: damian.romero@barcelonagse.eu

Resumen

Este artículo intenta abordar la interrogante sobre cómo las políticas monetarias no convencionales afectaron las expectativas de mercado sobre la trayectoria esperada de la tasa de política monetaria y el crecimiento económico en países donde algún tipo de política monetaria no convencional fueron aplicadas. El enfoque utilizado en este trabajo compara las expectativas implícitas de la curva de rendimiento con encuestas de mercado (para la tasa de política monetaria) y modelos econométricos (para el crecimiento económico) y así evaluar la precisión de cada una para proyectar a diferentes horizontes. Se concluye que en dicho periodo donde se aplicaron políticas no convencionales, la curva de rendimiento entregó información relevante a la hora de proyectar tanto la tasa de política monetaria como el crecimiento, especialmente en países desarrollados.

Palabras clave: *Estructura de tasas, políticas monetarias no convencionales, proyección económica.*

Clasificación JEL: *E43, E44, E47, E58.*

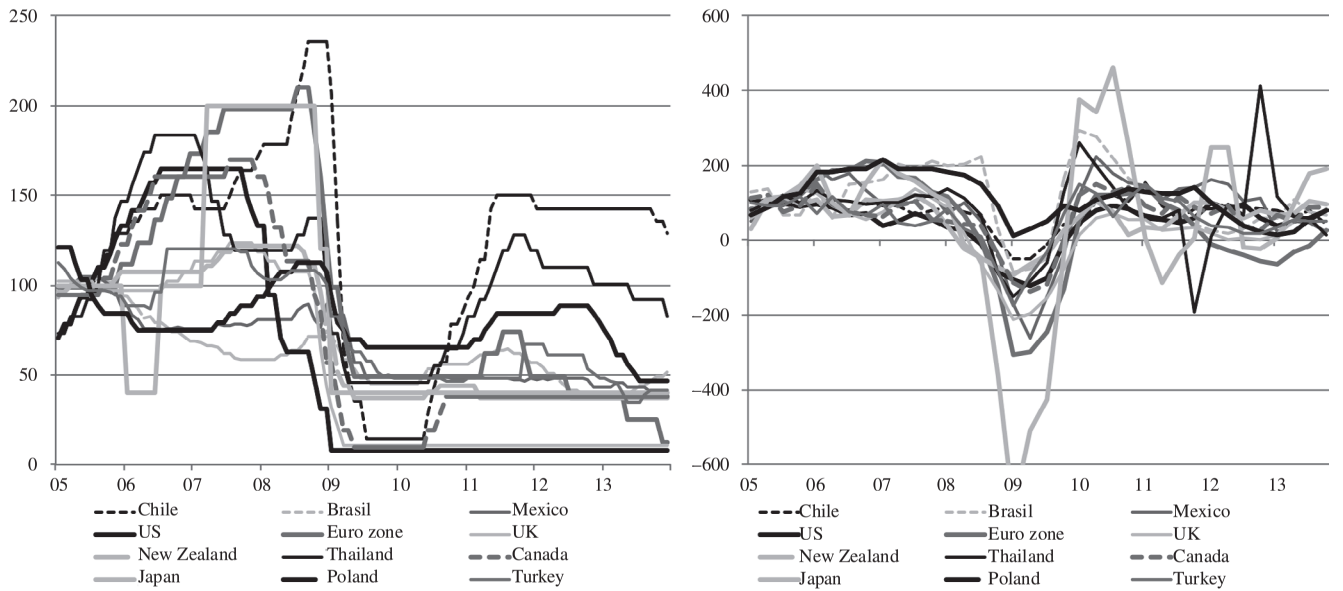
1. INTRODUCTION

The conventional monetary policy (understood as changes in the level of the monetary policy interest rate) seeks to influence the expectations of market participants about the future path of interest rates, affecting asset prices and therefore the level of output in the economy. The transmission mechanism can be summarized in two processes. The first process involves the propagation of changes in monetary policy through the financial system. Therefore movements in the monetary policy rate (MPR) lead to changes in asset prices (i.e. bond and bank loans) affecting the spending decisions of individuals and firms. The second process is related to the propagation of the MPR from financial assets to the real economy in both aggregate output and prices.

However, after the onset of the financial crisis in 2008 caused by the subprime mortgage crisis in the US, conventional monetary policy described above gave way to a new form of so-called unconventional monetary policy. During this period different economies experienced a contraction of output while some countries reached a lower bound for the monetary policy rate as Figure 1 illustrates for a selected group of countries that applied unconventional monetary policies. Also during this period, some governments took actions to provide liquidity in foreign currency and monetary markets, and additional unconventional policies were adopted to reinforce the credibility of announcements that the monetary policy rate would be kept low for a long time. All the financial turmoil exhibited during that period might have affected the information derived from bonds related to the future path of the MPR and therefore future economic growth.

FIGURE 1

MONETARY POLICY RATE AND GDP GROWTH



Left chart correspond to monthly monetary policy rate expressed as index (2005 = 100). Right chart correspond to quarterly Gross Domestic Product growth expressed as index (2005 = 100).
Sources: Centrals Banks and Bloomberg.

The different unconventional policies adopted by various central banks, especially during the period 2008-2009[1] can be grouped into (1) liquidity and exchange rate easing, (2) credit and quantitative easing, and (3) forward guidance as Ishi *et al.* (2009) and IMF (2013) enumerates. For example, Moessner (2013) studied the effect of explicit policy rate guidance. It is important to remark that the last two types of unconventional policies affected directly the structure of interest rates, and therefore, the information regarding the future path of the MPR and economic growth.

The aim of this study is to assess whether the information contained in the structure of interest rates (in particular whether the adoption of unconventional monetary policies) affected expectations of future MPR path and activity derived from bonds. We evaluate and compare the expectation of MPR and economic growth for a group of countries that applied unconventional monetary policies based on interest rates, and other benchmarks as surveys (for the MPR) and autoregressive models (for economic growth). Those countries are characterized by having adopted some type of unconventional monetary policy in the period 2005-2013.

Our approach relies in the accuracy of the yield curve to predict the short-term interest rate path and economic growth up to 12 months in different monetary policy regimes. Most research reveals that the term spread helps to predict economic growth in the short-term horizon and it has been employed mainly in US such as Rudebusch & Williams (2009), Liu & Moench (2014), Saar & Yagil (2015a) among others[2]. For other economies, Saar & Yagil (2015b) find evidence that government and corporate bonds predict economic growth for some European and Asian economies.

However, our approach differs from previous studies due we focus and compare how the relative performance between expectations based on the yield curve respect to alternative sources changed in the sample where the unconventional monetary policies were implemented.

Our findings suggest that the forecast of the short-term interest rates in most countries have same predictive power between the expected interest rate derived from bond yields and market-based surveys, so the expectations derived from bond was not affected in such period. Also, we evidence for the economic growth evaluation, that the inclusion of the yield curve information outperformed alternative models, especially in developed countries.

The paper is organized as follows. Section 2 presents the methodology used to compute the expected short-term interest rate and forecast future economic growth. Section 3 presents the data description, in section 4 we present the empirical results and finally the section 5 concludes.

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1 For instance, Céspedes *et al.* (2011) compile a list of fifty-six policy announcements regarding unconventional policies, in the period from September 2008 to October 2009, for a group of thirteen central banks.

2 A complete revision is made by Wheelock & Wohar (2009).

2. METHODOLOGY

2.1. The yield curve

We can compute three factors of the yield curve defined as the level, slope and curvature (see Diebold & Li (2006) for a detailed revision) and use them to analyze their relation with the rest of the economy. To compute the factors of the yield curve, we employed the Nelson & Siegel (1987) model which according to the BIS (2005) is one of the most used models by different central banks due to its easy computation and good fit to observed interest market rates. The model can be written as:

$$y_t^{\tau} = \beta_{0,t} + \beta_{1,t}\left[\left(1 - e^{-\lambda\tau}\right) / \lambda\tau\right] + \beta_{2,t}\left\{\left[\left(1 - e^{-\lambda\tau}\right) / \lambda\tau\right] - e^{-\lambda\tau}\right\} \quad (1)$$

where y_t^{τ} corresponds to the interest rate observed at maturity τ in time t. The model (1) calibrates parameters $\{\beta_0, \beta_1, \beta_2, \lambda\}$, such that the error between the market rates and the estimated rates derived from the model are minimized.

In order to obtain the parameters from (1), we proceed to fix the λ parameter of the model[3] for two reasons: (a) When this parameter is fixed, the model is linear and can be estimated by OLS for each date, generating a time series for each factor, and (b) changes in the parameters (factors) in (1) can be interpreted as changes in the level, slope and curvature of the yield curve, and those are the relevant elements to take into account when analyzing its importance in the economy.

2.2. Monetary policy rate expectations

To assess the MPR forecast, we consider two sources of information. The first refers to the expected MPR implicit in the yield curve based on the forward rate structure proposed by Nelson & Siegel (1987) denoted in (1). Thus, the expected forward rate at maturity τ in period t $\left(f_t^{\tau}\right)$ is denoted as:

$$f_t^{\tau} = \beta_{0,t} + \beta_{1,t}e^{-\lambda\tau} + \beta_{2,t}\lambda\tau e^{-\lambda\tau} \quad (2)$$

This information corresponds to the expectations that the market has regarding future changes in the MPR. The second source is the estimation of analysts and investment banks in each economy reported by Consensus Forecast Survey (CF). The latter reflects the MPR's expected future path based on a survey. In both cases we

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[3] The parameter calibrated ranges from 0.07 to 0.12 for different countries. Different values of this parameter do not change our results qualitatively. Note that Diebold & Li (2006) as well as for example Dolan (1999) and Fabozzi *et al.* (2005) first fix λ to a pre-specified value and then proceed with analyzing the three-factor model.

consider the forecast horizon at three and twelve months (the periods for which we have available data for CF). Thus, we proceed to compute the forecast error measured as:

$$e_t^j = MPR_{t+h} - E_{t+h}^j(MPR) \tag{3}$$

where MPR_{t+h} denotes the effective monetary policy rate at horizon $t+h$, $E_{t+h}^j(MPR)$ indicates the expectation in time t for MPR h months ahead based on forecast source j (either bond prices or CF). In each case, we estimate the model and produce forecasts for both horizons (three and twelve months ahead), evaluating the accuracy of the forecast as:

$$d_t = g\left(e_t^{bond}\right) - g\left(e_t^{CF}\right) \tag{4}$$

where $g(\bullet)$ is the loss function represented by the squared error, as is usual in the literature.

Then using the series generated in (4), we run a Diebold & Mariano (1995) test using the small sample correction proposed by Harvey *et al.* (1997) and evaluate the accuracy of each forecast at different horizons.

An important issue with this framework is the assumption that the expected path of the short-interest rate is fully characterized by (2), so the expectation hypothesis holds for any maturity and the long-term interest rates correspond to an average of future path of short-term interest rates and the term premium is equal to zero. However, many authors have argued that the term premium play a relevant role in the behavior and dynamic of interest rates. For instance, Wright (2011) document the term premium for several developed countries, and Blake *et al.* (2015), Ceballos *et al.* (2015) and Espinosa *et al.* (2014) for other LATAM economies. However, our analysis focus on the expected short-term interest rate up to 12 months ahead, which has been documented by some authors to exhibit a term premium is close to zero (Ceballos *et al.* (2015) for the Chilean market and Adrian *et al.* (2013) for US market). Additionally, we follow the standard approach used by many Central Banks described in BIS (2005), in which the computation of expected interest rate follows mostly non-parametric model fitting observed interest rates in the money and bond markets and no derivation neither identification of term premium is carried out.

Finally, we could consider alternative models attempting to measure the expected path of short-term interest rates as affine models, structural models, among others. However, we consider that most of alternative models suffers from (1) real-time error estimation, which occurs when the model-parameter are re calibrated once the new information arrives or even when first releases of economic data (as CPI, activity, etc.) are changed, and (2) in the zero-lower bound framework that most developed countries have experienced the last years, such models have performed significantly worse than alternative models (see Bauer & Rudebusch (2015)). Furthermore, Gürkaynak *et al.* (2014) have argued that market-based measures of monetary policy expectation

(derived from different financial instruments) provide forecast superior to alternative standard time series models.

2.3. Economic growth expectations

Following the literature (Estrella & Hardouvelis (1991) and Hamilton & Kim (2000) among others), we use the slope factor of the yield curve to predict output growth at different horizons. To do this, we estimate regressions of the $t + h$ periods ahead year-on-year growth rate of industrial production on a set of regressors in time t. For parsimony, we follow Estrella & Hardouvelis (1991) and Hamilton & Kim (2000), among others, and estimate the following model:

$$y_{t+h} = \alpha_0 + \sum_{i=1}^{p} \beta_i y_{t-i} + \gamma \Delta i_t^{6m} + \delta slope_t + \varepsilon_t \tag{5}$$

where y_{t+h} is the monthly growth of industrial production h periods ahead, Δi_t^{6m} is the change in the nominal short-term interest rate (specifically the 6-month interest rate) between period t and $t\text{-}1$ and $slope_t$ is the slope of the yield curve denoted by β_1 in model (1). Finally the lag-order p is set equal to three[4]. We evaluate the forecasting power of the slope, comparing model (5) with a modified version given by the following expression:

$$y_{t+h} = \alpha_0 + \sum_{i=1}^{p} \beta_i y_{t-i} + \gamma \Delta i_t^{6m} + \varepsilon_t \tag{6}$$

Equation (6) is the same as equation (5) but imposing the constraint $\delta = 0$. The specification (5) attempts to capture the additional information contained in the interest rates of bonds through the slope factor of the yield structure. Our procedure is recursive[5], so we first estimate both models in monthly frequency for the period January 2005-November 2007. Then the models incorporate new observations and are re-calibrated in order to make a forecast h-steps ahead. Finally, to evaluate the relative performance of each model, we compute the modified Diebold & Mariano (1995) test described in the previous section. The horizons taken in consideration are three, six, and twelve months ahead.

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[4] We test with different lag-order (1 to 6) and results are robust. Also we evaluate an alternative specification considering the annual growth rate of industrial production and we evidence similar results.

[5] However, as a robust exercise, we evaluate a rolling specification which leads similar results, which is reported in Appendix B.

3. DATA

The empirical work considers 12 developed as well developing economies. In particular, we follow the IMF's country classification and consider two categories: (1) developed economies and (2) emerging economies. The first group is related to the major advanced economies and corresponds to the largest in terms of GDP. The second group considers six emerging countries. The Table 1 shows the countries considered and other variables used in this work.

TABLE 1

DATA DESCRIPTION

Country	Classification	Economic growth	Frequency	Source
Brazil	EME	Industrial Production	Monthly	Bloomberg
Canada	DEV	Monthly GDP estimation	Monthly	Bloomberg
Chile	EME	Economic activity (IMACEC)	Monthly	Bloomberg
Euro Zone	DEV	Industrial Production	Monthly	Bloomberg
Japan	DEV	Industrial Production	Monthly	Bloomberg
Mexico	EME	Industrial Production	Monthly	Bloomberg
New Zealand	DEV	Business Performance Manufacturing index	Monthly	Bloomberg
Poland	EME	Industrial Production	Monthly	Bloomberg
Thailand	EME	Industrial Production	Monthly	Bloomberg
Turkey	EME	Industrial Production	Monthly	Bloomberg
UK	DEV	Industrial Production	Monthly	Bloomberg
US	DEV	Industrial Production	Monthly	Bloomberg

This table shows the interest rate data and economic activity proxy used.

For the construction of nominal yield curve we consider quoted local currency government bond reported at daily frequency by Bloomberg in both monetary market for maturities shorter than one year, and transaction quotes in the bond market for maturities longer than one year. The maturities considered are 3, 6, 12, 24, 60 and 120 months[6].

For the evaluation of the expected monetary policy rate we use the Consensus Forecast information as the Survey-based forecast evaluation. In particular, we consider the expected nominal short-term interest rate expected at three and twelve months ahead in each economy. Also, for the economic growth evaluation, we consider different proxies for monthly economic growth instead to use directly GDP

[6] The Appendix A summarizes the financial instrument used to calibrate the yield curve in each economy.

indicator. We follow this approach due to consider data with monthly frequency instead a lower frequency[7].

4. EMPIRICAL RESULTS

Besides analyzing market expectations in the whole period, we take into consideration two subsamples which were characterized by different expectation disruptions as a way to get robust results. The first subsample, spanning December 2007 to July 2009, was characterized by historical increase in the risk indicators, episodes of turbulence in financial markets, significant slowdown in production and a decrease to the lowest MPR level in each economy. Also during this period the first types of unconventional monetary policies aimed to normalize the functioning of financial markets and stimulate the economy began being implemented. The second subsample, spanning August 2009 to December 2013, was characterized by decreases in the risk levels as well as a gradual recovery of output in most countries. Table 2 presents the Diebold-Mariano tests over the MPR forecast based on interest rates and those reported by CF taking into consideration different subsamples.

The evidence suggests that for most developed economies, the information of the yield curve have no marginal extra information regards the future path of the short-term interest rate shown in Table 2. Thus, in Canada, and New Zealand there is no gain to use the information embedded in the yield curve. The opposite occurs in Japan and UK, in which the yield curve have a better predictive power of the yield curve regarding the market-based survey. In the Eurozone and US the yield curve provides no improvement in forecast the short-term interest rates. In the case of emerging economies, only Turkey shows that the information derived from bonds allows a better forecast of the MPR in both short and long horizon considering the total sample. However, by considering the first subsample, there is no evidence that information contained in bond interest rate leads an accuracy estimation of future MPR movements. In fact, a lower forecast error based CF in the three-month horizon is evidenced in the Poland case. Meanwhile, when considering the second subsample shows that there is no gain from yield curve except for Poland.

In the economic growth forecasting evaluation presented in Table 3, we find evidence of predictive ability of the slope on output growth in most of the countries. As shown in the table, we find some cases when the forecast of the alternative model (equation 6) is more accurate, as Japan economy. In contrast, we report several cases when the performance of the slope is relevant to predict output growth, and these are statistically significant. For instance, in developed countries as Eurozone, New Zealand and US there are marginal gains considering bond information depending horizon, as well in emerging countries as Mexico, Poland, and Turkey.

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[7] In fact, there is a high correlation between the quarterly economic activity indicator and the GDP growth which registers a correlation of 0.93 and varies from 0.76 to 0.99 depending the country.

TABLE 2

MONETARY POLICY RATE FORECAST EVALUATION

	Full sample		Subsample A		Subsample B	
	h=3	h=12	h=3	h=12	h=3	h=12
Brazil	1.02	0.91	1.42	0.69	–0.33	–0.33
	0.31	0.36	0.17	0.50	0.75	0.75
Canada	–1.10	–1.02	–1.16	–0.56	–0.60	–0.59
	0.27	0.31	0.26	0.58	0.55	0.56
Chile	–0.74	–0.68	–0.47	–0.23	–0.28	–0.35
	0.45	0.50	0.65	0.82	0.78	0.73
Euro Zone	–0.16	–0.25	–1.50	–0.73	5.85	4.30
	0.87	0.80	0.15	0.48	0.00	0.00
Japan	–4.21	–4.26	–5.22	–2.53	–2.95	–2.30
	0.00	0.00	0.00	0.02	0.00	0.03
Mexico	0.99	0.94	1.17	0.57	0.79	1.29
	0.33	0.35	0.26	0.58	0.44	0.20
New Zealand	1.61	1.50	1.48	0.72	0.60	0.28
	0.11	0.14	0.16	0.48	0.55	0.78
Poland	–0.93	–0.87	2.61	1.26	–0.75	–0.26
	0.35	0.39	0.02	0.22	0.45	0.79
Thailand	–1.10	–0.78	–1.15	–0.56	–1.44	–0.31
	0.27	0.44	0.26	0.58	0.16	0.76
Turkey	–4.66	–4.21	–0.43	–0.21	–5.34	–3.36
	0.00	0.00	0.67	0.84	0.00	0.00
UK	1.03	1.00	1.60	0.78	–3.88	–3.30
	0.31	0.32	0.13	0.45	0.00	0.00
US	1.77	1.74	2.38	1.15	1.24	1.63
	0.08	0.09	0.03	0.26	0.22	0.11

The table reports the modified Diebold-Mariano test and *p*-values. Under the null, both models have the same predictive power, while under the alternative is different. When the Diebold-Mariano statistic is negative and statistically significant, this represents evidence in favor of the predictive power of model based bond interest rates. Full sample corresponds to December 2007 to December 2013, Subsample A corresponds to December 2007 to July 2009 and Subsample B corresponds to August 2009 to December 2013.

TABLE 3

ECONOMIC GROWTH FORECAST EVALUATION

	Full sample			Subsample A			Subsample B		
	h=3	h=6	h=12	h=3	h=6	h=12	h=3	h=6	h=12
Brazil	–1.45	–0.57	–0.01	–1.32	0.21	–0.70	–0.99	–0.60	0.88
	0.15	0.57	0.99	0.20	0.83	0.49	0.33	0.55	0.38
Canada	0.67	–0.64	–0.59	1.00	–0.22	–0.37	–0.01	–0.83	–0.28
	0.51	0.53	0.56	0.33	0.83	0.72	0.99	0.41	0.78
Chile	–0.66	–0.82	0.23	–0.96	–0.42	–0.24	–0.15	–0.55	0.88
	0.51	0.41	0.82	0.35	0.68	0.81	0.88	0.58	0.38
Euro Zone	–1.99	–0.73	0.26	–0.71	–1.83	–1.38	–1.96	0.11	1.71
	0.05	0.47	0.79	0.49	0.08	0.18	0.06	0.91	0.09
Japan	3.10	1.67	0.56	1.25	–1.12	–0.22	4.60	2.68	1.99
	0.00	0.10	0.58	0.22	0.28	0.83	0.00	0.01	0.05
Mexico	0.74	–2.19	–1.84	1.01	–0.13	–0.60	–0.14	–2.34	–1.21
	0.46	0.03	0.07	0.33	0.90	0.55	0.89	0.02	0.23
New Zealand	–1.12	–1.48	–1.39	–1.76	–0.34	–0.74	0.29	–1.51	–1.13
	0.27	0.14	0.17	0.09	0.74	0.47	0.77	0.10	0.26
Poland	–1.10	–1.79	–1.48	–1.05	–1.13	–1.02	–0.51	–1.26	–0.06
	0.28	0.08	0.14	0.31	0.27	0.32	0.61	0.21	0.95
Thailand	–1.34	–0.38	–0.05	–1.08	–0.08	–0.16	–0.94	–0.46	0.43
	0.18	0.71	0.96	0.29	0.94	0.87	0.35	0.64	0.67
Turkey	–2.05	–2.19	–1.84	–1.45	–1.07	–0.99	–1.46	–1.49	–1.05
	0.04	0.03	0.07	0.16	0.30	0.34	0.15	0.14	0.30
UK	0.69	–0.53	–0.50	0.81	–1.23	–0.29	–0.70	0.25	–0.06
	0.49	0.60	0.62	0.43	0.23	0.77	0.49	0.81	0.95
US	–2.32	–1.41	–1.76	–0.16	–0.07	0.16	–2.78	–1.40	–2.12
	0.02	0.16	0.08	0.88	0.94	0.88	0.01	0.17	0.04

This table reports the modified Diebold-Mariano test and *p*-values. Under the null, both models have the same predictive power, while under the alternative is different. When the Diebold-Mariano statistic is negative and statistically significant, this represents evidence in favor of the predictive power of model based bond interest rates. Full sample corresponds to December 2007 to December 2013, Subsample A corresponds to December 2007 to July 2009 and Subsample B corresponds to August 2009 to December 2013.

As we have mentioned, the implementation of unconventional monetary policies had a direct impact on interest rate through the purchases of government bond. So we focus in how the yield curve information outperformed the survey-based expectation and alternative autoregressive models for output growth, especially during the second sample (August 2009 to December 2013) respect the prior sample. When we evaluate the predictive performance for the short-term interest rate path, we find that in those countries where the yield curve provided relevant information in the first sample, it was also hold during the second sample (Japan). For the other economies (except Eurozone, Poland and US), the relative performance between the yield curve and market-based survey had no differences. Finally, in Poland and US, the best performance of market-based surveys in the first sample changed in the second sample where both yield curve and survey provided similar information. Thus, we conclude that in almost all countries the yield curve information did not deteriorate the information implicit in interest rates regard other sources in the period where UMP was implemented.

A more notorious result we evidence in the economic growth exercise. For most emerging countries (except Mexico), there is no marginal gain considering yield curve information in both subsamples. In contrast, in Mexico and US, the slope component generated an accurate forecast of economic growth in the second subsample, whereas in the first sample the inclusion of the yield curve slope did not produce better forecast.

To sum up, we observe that the inclusion of the yield curve information to forecast the short-term interest rate and economic growth, in most cases did not impact negatively the expectations for those variables, and the opposite was observed, specially forecasting economic growth for developed countries. Thus, the implementation of unconventional monetary policies did not alter market expectation implicit in financial instrument (in our case bond yields).

5. CONCLUSIONS

After the onset of the financial crisis in 2008 caused by the sub-prime mortgage crisis in the US, different economies implemented unconventional policies in order to reinforce the idea that the monetary policy rate would be kept low for a long time and stimulate the economic growth. Thus, the information embedded in the yield curve (interest rates from government bonds) may be affected for the implementation of UMP.

In this paper we evaluated the expectation derived from the yield curve regards future path of the short-term interest rates as well as forecasting economic growth for several developed and emerging economies in the period 2005-2013. For measuring the expected path of interest rates we rely in the forward interest rates under the model proposed by Nelson & Siegel (1987) which is one of the most common methodologies employed by other Central banks according to BIS (2005) and compared such forecast with market-based survey (Consensus Forecast) for three and twelve month ahead. We evaluate the performance of each source using the Diebold-Mariano test considering the small sample correction proposed by Harvey *et al.* (1997). A similar exercise if

carried out for economic growth evaluation, based on a time series model following Hamilton & Kim (2000) where the yield curve expectation is measured for the slope component.

We compared the relative performance between expectations based on the yield curve respect to alternative sources changed in the sample where the unconventional monetary policies (UMP) were implemented. Thus, we focus on the sample prior the implementation of UMP (before middle 2009) and the period of time which consider July 2009 to December 2013.

Our findings suggest that the forecast of the short-term interest rates in most countries have same predictive power between the expected interest rate derived from bond yields and market-based surveys, so the expectations derived from bond was not affected in such period. Also, we evidence for the economic growth evaluation, that the inclusion of the yield curve information outperformed alternative models, especially in developed countries.

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APPENDIX A: DATA SOURCE

This table shows the selected interest rates to compute the parametric model of Nelson & Siegel (1987). For maturities <= 1 year we consider three maturities 3m, 6m and 12m. For maturities < 1year, we consider maturities for 2y, 5y and 10 years.

TABLE A1

DATA SOURCES FOR INTEREST RATES

	Interest rates 1y	Interest rates 1y
Brazil	Interest rates swaps	Government bonds
Canada	Government treasury-bills	Government bonds
Chile	Interest rates swaps	Government bonds
Euro Zone	Generic Euro government bills and bonds	Government bonds
Japan	Government treasury-bills	Government bonds
Mexico	Government treasury-bills	Government bonds
New Zealand	Government treasury-bills	Government bonds
Poland	Interbank rates	Government bonds
Thailand	Thai bond dealing centre; interpolation of selected bond near to maturity	Government bonds
Turkey	Bank association of Turkey TRLibor rates	Government bonds
UK	London Interbank offered rate (LIBOR in US dollar)	Government bonds
US	London Interbank offered rate (LIBOR in pounds)	Government bonds

APPENDIX B:
ECONOMIC GROWTH ROLLING ESTIMATION

This table reports the modified Diebold-Mariano test and *p*-values. Under the null, both models have the same predictive power, while under the alternative is different. When the Diebold-Mariano statistic is negative and statistically significant, this represents evidence in favor of the predictive power of model based bond interest rates. Full sample corresponds to December 2007 to December 2013, Subsample A corresponds to December 2007 to July 2009 and Subsample B corresponds to August 2009 to December 2013.

TABLE B1

ECONOMIC GROWTH FORECAST EVALUATION

	Full sample			Subsample A			Subsample B		
	h=3	h=6	h=12	h=3	h=6	h=12	h=3	h=6	h=12
Brazil	–0.75	–0.99	–0.59	–1.17	–0.97	–0.57	–0.20	–0.48	–0.14
	0.46	0.33	0.56	0.25	0.34	0.58	0.84	0.64	0.89
Canada	0.32	0.18	0.21	0.21	0.17	0.10	0.30	0.00	0.11
	0.75	0.86	0.83	0.84	0.87	0.92	0.76	1.00	0.92
Chile	–0.74	–0.66	–0.84	–0.45	–0.38	–0.22	–0.49	–0.41	–0.62
	0.46	0.51	0.40	0.66	0.71	0.83	0.63	0.68	0.54
Euro Zone	–2.42	–1.69	–0.46	–2.17	–1.80	–1.05	–2.31	–1.50	–0.27
	0.02	0.09	0.65	0.04	0.09	0.30	0.03	0.14	0.79
Japan	–0.10	–0.26	0.08	–2.08	–1.72	–1.01	0.45	0.28	0.63
	0.92	0.79	0.94	0.05	0.10	0.33	0.65	0.78	0.53
Mexico	–1.70	–1.61	–2.13	–1.68	–1.39	–0.81	–0.88	–0.86	–1.45
	0.09	0.11	0.04	0.11	0.18	0.43	0.38	0.40	0.15
New Zealand	–1.66	–1.43	–1.16	–1.65	–1.37	–0.80	–0.61	–0.44	–0.17
	0.10	0.16	0.25	0.12	0.19	0.43	0.54	0.66	0.86
Poland	–2.48	–2.67	–1.85	–1.75	–1.45	–0.85	–1.55	–1.76	–0.84
	0.02	0.01	0.07	0.10	0.16	0.41	0.13	0.08	0.40
Thailand	–1.26	–0.23	–0.16	–1.27	–1.05	–0.62	–0.87	0.36	0.45
	0.21	0.82	0.87	0.22	0.31	0.55	0.39	0.72	0.65
Turkey	–1.80	–2.19	–1.18	–1.89	–1.57	–0.92	–1.11	–1.48	–0.62
	0.08	0.03	0.24	0.07	0.13	0.37	0.27	0.15	0.54
UK	–1.48	–1.85	–1.29	–1.31	–1.08	–0.63	–0.80	–1.19	–0.62
	0.14	0.07	0.20	0.21	0.29	0.53	0.43	0.24	0.54
US	–0.61	–1.06	–0.86	–0.66	–0.54	–0.32	–0.32	–0.77	–0.58
	0.54	0.29	0.39	0.52	0.59	0.75	0.75	0.44	0.56

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FINANCIAL RISK OF URUGUAYAN HOUSEHOLDS*

RIESGO FINANCIERO DE LOS HOGARES URUGUAYOS

FERNANDO BORRAZ**
Banco Central del Uruguay and dECON-FCS-Udelar

NICOLAS GONZALEZ PAMPILLON***
IEB & Universitat de Barcelona

Abstract

This study analyzes the financial risk of Uruguay households using the first nationally representative Uruguayan financial survey. The objective of this work is twofold. First, we simulate the impact on the finance of Uruguayan households of a negative income shock similar to the one experienced in 2002, finding that the financial risk is mild. We estimate a 175% increases in the number of households with financial burden higher than 0.75. Despite this big raise, this group is 10% of the population. Furthermore, the debt level is low in international terms. Secondly, we analyze over indebtedness among Uruguayan households. We observe that some variables are correlated with the fact of being over indebted. Nevertheless, when using the burden financial ratio as dependent variable we find that few variables can significantly explain it.

Keywords: *Financial risk, household over indebtedness, financial survey, Uruguay.*

JEL Classification: *C5, D14.*

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** E-mail: fborraz@bcu.gub.uy. Diagonal Fabini 777, Montevideo-Uruguay. Phone: 598 99 209434.

*** E-mail: nfgonzalez@ub.edu. c/Tinent Coronel Valenzuela, 1-11, 08034 Barcelona-Spain. Phone: 34 93 403 46 46.

Resumen

Este estudio analiza el riesgo financiero de los hogares de Uruguay utilizando la primera encuesta financiera uruguaya representativa a nivel nacional. El objetivo de este trabajo es doble. En primer lugar, se simula el impacto en las finanzas de los hogares uruguayos de un shock negativo a los ingresos similar al experimentado en 2002, encontrando que el riesgo financiero es leve. Estimamos un aumento del 175% en el número de hogares con carga financiera superior a 0,75. A pesar del importante crecimiento, este grupo representa solo el 10% de la población. Además, el nivel de deuda es bajo en términos internacionales. En segundo lugar, se analiza el sobreendeudamiento de los hogares uruguayos. Encontramos que algunas variables se correlacionan con el hecho de estar sobreendeudado. Sin embargo, cuando se utiliza como variable dependiente el ratio de carga financiera a ingreso encontramos que pocas variables pueden significativamente explicarlo.

Palabras clave: *Riesgo financiero, sobreendeudamiento de los hogares, encuesta financiera, Uruguay.*

Clasificación JEL: *C5, D14.*

I. INTRODUCTION

Understanding micro-level information of household assets and liabilities is a policy relevant topic for several reasons. First, it is useful to uncover the indebtedness mechanisms of households and analyze which are its main drivers. Second, it could be helpful to evaluate the impact of negative shocks, institutional frameworks or policies on the financial vulnerability of households. Third, it could contribute to understand more broadly monetary policy transmission and financial stability. The analysis of the financial balance sheet of households plays a key role from a financial stability perspective. Finally, it could be useful to identify households which are more exposed to financial risks.

This research has two objectives. The first one is to stress the self-reported financial burden of households under a harmful scenario. To do so, we predict the household income that would arise after a negative earning shock similar to the one experienced in 2002 in Uruguay. The second objective is to calculate a debt indicator; in particular, we focus on the debt services over income ratio (financial burden) and in the debt assets ratio at the household level. Based on these indicators we compute a binary variable that takes the value of one in the case of household with a ratio above 60% or 80% (these thresholds are commonly used in the literature to define over indebtedness households). These indicators will enable us to identify groups of households exposed to financial risk and also to investigate which household characteristics are predictive of household over indebtedness. We pay special attention to household labor market characteristics such as the number of unemployed household members. We identify

the main explanatory variables related to the fact of being over indebted. Finally, this analysis will enable us to find out whether there is heterogeneity across income groups.

One potential concern with indebtedness indicators such as the service debt-income or assets-liabilities ratio is related to missing data or measurement error. For instance, some members of the households can refuse to report their financial burden. Fortunately, in our dataset less than ten percent of the households did not report the financial burden. Additionally, some household members could be transitorily unemployed and their disposable income be zero leading to an alternative source of extreme values. In order to avoid this problem, we compute these indicators based on the households ability to generate income. That is, first, we estimate a Mincer equation to take into account the households capacity to generate income in the long run to honor their debts. We use the Heckman methodology to account for individuals with zero income[1]. We also consider separate regression for men/women, public/private, wage earners/self employment. Second, we predict the employment status and the income for individuals that do not report earnings. In this latter case we assume people that are unemployed or out of the labor force will become wage earners. Therefore, we are evaluation the household capacity to honor the debt in the long run.

According to the Central Bank of Uruguay (BCU (2012)) the solvency status of Uruguayan financial institutions ten years after the 2002 economic and financial crisis is characterized by two peculiarities. The first one is the capital surplus, which makes it lie loosely above the minimum required by the prudential regulation (on average twice the regulatory requirement). The second one consists on the prudential regime of statistical forecasts established by the regulator (BCU), which provides that banks take losses at the peak of the economic cycle to create a fund that allows coping with the increases in non-performing loans without raising additional capital in times of recession. The financial system report of BCU (2012) point out that the banking systems could support a stress test of crisis while, on average, support a scenario of crisis while maintaining a reasonably appropriate heritage level[2].

This study is based on the 2012 Financial Uruguayan Household Survey (FUHS). The FUHS is a module of the National Household Survey (ECH) and it was performed in the last quarter of 2012 and the beginning of 2013. The FUHS surveyed a sub-population of the ECH (about 8,000 households) and then, it will enable us to have a picture of the financial characteristics of Uruguayan households. Because the FUHS is a module of the ECH it is a nationally representative survey.

We compare the self-reported financial burden of Uruguayan households with the financial burden that results from considering a negative earning and employment shock similar to the one experienced by the Uruguay economy in 2002[3]. We also recalculate the financial burden of households under the assumption of a reduction in the public cash transfer to the poorest households. We perform this exercise because an important proportion of the disposable household income of poor household are linked to transfers and per capita real transfers fell substantially during the 2002 episode.

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1 This is particular relevant for women.

2 For a detailed description of the Uruguayan financial system in 2012 see BCU (2012).

3 The GDP decreased 12% in 2002.

The results show that the financial risk of Uruguayan households is mild. Despite the fact that we estimate a 175% increases in the number of households with financial burden higher that 75% their share in the population is 10%. Therefore, we do not obtain an important increase in household financial indicators after a shock similar to the one experienced by the Uruguayan economy in 2002. This means that the lower GDP and higher rate of unemployment due to the negative shock does not necessarily imply that the financial sector should be facing a major cessation of payments scenario. Further research is required in order to analyze how unemployment shock affects decision related to acquiring debts. In particular, in order to estimate a causal effect, panel data is required.

The paper is organized as follows; in the second section we present a brief literature review related to financial risk and over indebtedness; section three describes the FUHS survey; in section fourth we present the methodology; in the fifth section results are presented and finally we conclude.

II. LITERATURE REVIEW

Because the level and composition of household debt are key elements in the analysis of financial stability it is not surprising that Central Banks in developed countries (US, Italy, Spain, etc) and in developing countries (Chile, Colombia, etc) are performing household financial surveys. Uruguay is not isolated to this trend and in 2012 the Central Bank of Uruguay performed the first household finance survey. Based on such surveys the literature analyzes the household financial vulnerability.

Herrala and Kauko (2007) use the Finland financial survey to microsimulate a model of household distress to find that households risk are low. In the case of Britain households, Del Río and Young (2005) find that the main determinant of debt problems is the unsecured debt-income ratio.

For a developing economy, Fuenzalida and Ruiz-Tagle (2009) based on the Chilean household finance panel find that the main weakness is the lost of labor income. They find that an increase of one percentage point in the unemployment rate increases the debt at risk between 0.6 and 0.8 points. Interestingly, their simulations for the debt at risk indicate that the risk is relatively limited.

A correction in the debt to service ratio is presented in Martínez *et al.* (2011) who show that increases in the unemployment rate and the debt service increase the probability of default; and income and age decrease this probability. However, they cannot find a threshold value in the debt to service ratio to predict default.

Alvaréz and Opazo (2013) analyze the case of Chile after the 2008 financial crisis. They find a negative relationship between income shocks and debt because household smooth consumption. Also, they find heterogeneity effect across households and types of debt. Also for the case of Chile, Alfaro and Gallardo (2012) analyze the determinants of default. They find that income-related variables are the only ones that scientifically can explain the probability of mortgage and consumer credit default. Interestingly, they find that social or demographic variables can explain only one type of default.

A recent study using the same dataset that us finds that a set of socio-economic variables can significantly explain household debt in Uruguay (Mello and Ponce (2014)).

With regard to the issue of over indebtedness, Ruiz Tagle *et al.* (2013) find that it increases with income. They also find that there is a substantially change in the debt burden of poor individuals when considering the earning capacity of the households. Therefore, the uncorrected debt burden indicators may hide the true ability to pay. We will take this fact into account in the impact estimation of a negative income shock.

Finally, D'Alessio and Iezzi (2013) analyze the determinants of over indebtedness of Italian Households. They find that over indebtedness is not only related with income but with poverty.

III. DATA

In order to undertake this research, we used two datasets: 1) the yearly Uruguayan National Household Survey *(Encuesta Continua de Hogares*, ECH) from 2001 to 2012, which is conducted by the National Statistical Office of Uruguay (*Instituto Nacional de Estadística,* INE); 2) the Financial Household Survey (*Encuesta Financiera de los Hogares Uruguayos,* EFHU), which is carried out by INE-BCU jointly with the Economics Department of the Social Sciences Faculty of Uruguay.

The ECH has been the main source of socio-economic information about Uruguayan households and their members at the national level since 2006, when it started to include rural areas. Prior to this year, the ECH only covered urban areas of the country. To have a comparable sample throughout the different years, we defined our sample unit as urban areas of more than 5,000 inhabitants of each department, which represents more than 80% of the total labor force in the department and, therefore, is representative of the whole work force in each of them.

Moreover, the selected sample is composed of male and female private wage earners and unemployed between 25 and 60 years old. We exclude public employees, entrepreneur, self-employed and inactive individuals. The ECH has information on monthly salaries net of social security and income taxes of each household member. We focus on the salaries from the main occupation. To construct the real hourly wage rate we divided the net real monthly salary by 4.28 times the number of hours worked in the main occupation.

The first edition of the EFHU was carried out in the last quarter of 2012 and in the first quarter of 2013 and it gathers financial information of households including debts, mortgage, other debts, the price of self-reported assets and other related financial issues[4]. Because the ECH in 2002 only include households in urban areas with more than 5,000 inhabitants, we restrict the analysis to this population[5].

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[4] See Sanroman *et al*. (2013) for a detailed description of the database.

[5] Note that only around the 5% of the Uruguay population is located in rural areas.

TABLE 1

CONSISTENCY BETWEEN DATA FROM EFHU AND BCU

	EFHU	BCU
Ratio of mortgage debt to bank financial debt	0.73	0.77
Ratio of bank credit to non-bank credit	0.29	0.28
Ratio of non mortgage debt in national currency	> 0.91	0.94

One concern is the consistency between the data from EFHU at the household level and the data from the Office of the Superintendent of Financial Institutions from the Central Bank based on information from financial institutions. Table 1 is based on Banco Central del Uruguay (2014) and EFHU and shows an important consistency between both sources of information.

According to the EFHU, approximately 90% of indebted families have manifested that more than 90% of the debt is denominated in domestic currency (consistent with BCU). Also, the ratio of mortgage debt to bank financial debt is 73% and 77% for EFHU and BCU respectively. On the other hand, the ratio of bank to non-bank credit is 29% and 28% respectively. Therefore we can conclude that the data from EFHU based on households is consistent with the data that report the financial institutions and also that non formal financial sources are relative small.

Table 2 shows summary statistics of several variables for the selected sample period of the ECH and also for the EFHU. One out of five households had taken credit for housing. However, sixty percent of them had already canceled their loan. The percentage of households with debts not related to housing is 37. Moreover, one in twelve household did not pay in full amount the credit card balance. Therefore almost half of the households (42%) do not have financial debts.

Next, we focus on the households' financial burden. The EFHU gathers information of monthly financial burden which is self-reported by one member of the household (usually the household's head)[6]. One common problem in the literature is to find missing data for the debt burden variables. However, in our sample only 9% of the households report missing values in the debt burden question. Therefore, in our case, the missing value problem is not an important issue. One drawback of this variable is that it is in discrete intervals. The level of household debt and financial burden is low in international terms (Alvarez and Opazo (2013)). For example, the share of households with financial burden higher than 50% is only 6%.

[6] The question related to self-reported financial burden and also the answers. In particular, the question is stated as follows: What percentage of the monthly household income is allocated to pay your own debts (including mortgage related to your main property); Answers: 1. Less or equal than 25% of the household income; 2. Between 26% and 50%; 3. Between 51% and 75%; 4. More than 75%; 5. Do not know?

TABLE 2

SUMMARY STATISTICS

ECH 2001-2012 (N=213,955)		
	Mean	S.D.
(ln) real hourly wage (UY pesos of 2010)	4.12	0.81
Education	9.78	3.69
Experience	24.14	11.25
Age	39.92	10.02
Share of females	0.51	0.50
Share of Montevideo	0.53	0.50
Fraction of full-time	0.62	0.48
EFHU 2012 (N=7,181)		
Credit for housing	20.58%	
Cancel credit for housing	12%	
Mortgaged as security for liabilities	6.35%	
Debts not related with housing	36.81%	
Not paid the full amount of the credit card balance last month	8.45%	
Financial burden		
To 25%	23.20%	41.35
Between 26% and 50%	12.12%	
Between 51% and 75%	4.50%	
More than 75%	1.53%	
Holding bank account	47.11%	
Holding other financial assets	1.11%	
	Mean	S.D.
Price of house – self-reported in USD	35,444	81,022
Price of other properties – self-reported in USD	12,549	85,247
Price of vehicles – self-reported in USD	4,119	13,225
Price of business – self-reported in USD	11,914	305,064
Amount of other bank debts in USD	1,580	12,179
Amount of other debts with other institutions in USD	418	3,685
Amount of debts with private in USD	127	2,861

IV. METHODOLOGY

The aim of this research is twofold. First, we compare the self-reported financial burden by Uruguayan households from the EFHU with the financial burden that result from considering a negative earnings shock similar to the one experienced in the 2002 crisis. Second, we identify over indebtedness households and find out the main explanatory variables related to the fact of being over indebted.

FIGURE 1

EVOLUTION OF THE AVERAGE (LOG) REAL HOURLY WAGE RATE

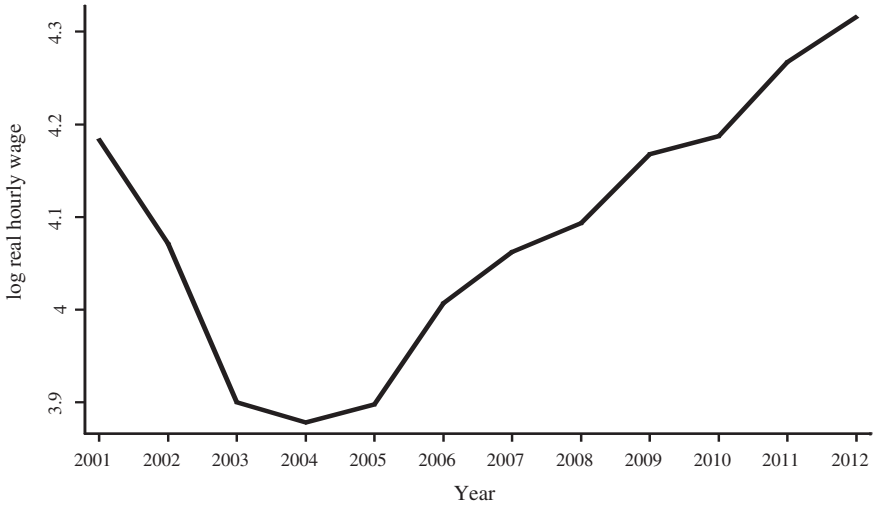

Figure 1 shows the evolution of the (log) real hourly wage for the period 2001-2012. We observe a steep fall between 2001 and 2003, which is linked to the deep economic and financial crisis experienced by the Uruguayan economy in 2002. After 2004 the real hourly wage rate starts to recover and increases until the end of the period under analysis. In order to evaluate this adverse scenario, we consider an (augmented) Mincer real wage equation including a dummy that accounts for the crisis period. Furthermore, since we are including unemployed individuals in our selected sample, we use the two stage Heckman method to correct for selection bias. Because we are estimating a Mincer equation to predict household wages we are evaluating the capacity of households to honor its debt in the long run.

The selection equation is:

$$E_i^* = \gamma_0 + \gamma_1 K_{i.o-6} + \gamma_2 K_{i,7-12} + \gamma_3 S_i^* + \gamma_4 Exp_i^* + \gamma_5 Exp_i^{*2} + \gamma_6 Crisis + \gamma_7 S_i^* Crisis + \gamma_8 X_i + u_i \quad (1)$$

and the wage equation is:

$$Ln(w_i) = \beta_0 + \beta_1 S_i^* + \beta_2 Exp_i^* + \beta_3 Exp_i^{*2} + \beta_4 Crisis + \beta_5 S_i^* Crisis + \beta_6 X_i + \varepsilon_i \quad (2)$$

where i is individual; E^* is latent employment, $Kids_{0\text{-}6}$ is the number of children between 0 and 6 years old in the households; $Kids_{7\text{-}12}$ is the number of children between 7 and 12 years olds in the households; $ln(w_i)$ refers to the log hourly real wage rate of the individual i; S_i* represents the true years of education; exp_i * denotes potential years of working experience and its square allows account for decreasing returns to this type of human capital accumulation; *Crisis* is a dummy variable that takes the value of one between July of 2002 and July 2003[7] and zero otherwise (this variable compares the crisis period with the non-crisis period); X is a set of controls that includes marital status, whether the member is the head of household, dummies for each department to account for demographic characteristics that affect the determination of wages and dummies for working sectors; finally, ε is an idiosyncratic error term.

Furthermore, similarly to Sanroman (2006), we include the interaction of the *Crisis* dummy with the number of years of education to analyze the effect of the crisis by schooling level. Also we include the interaction of the *Crisis* dummy with industry dummies to allow for the possibility of sectors being affected differently by the crisis. The estimation of the Mincer equation captures the capacity of individuals to generate income in the long-run. It is possible that some household members are not working and with zero wage. However, that does not mean that the can not obtain a wage if they decide to go to the labor market.

As usual in the literature we use as instruments for the exclusion restriction, the number of children between 0 and 6 years old and the number of children between 7 and 14 years old. We expect these variables to be correlated with the decision to work or not but not with the wage.

We have to stress that we only estimate using the Heckman method for private workers since public workers have tenure and are not affected by the negative employment shock. In addition, public workers present different characteristics compared with other type of workers such as greater job stability. Therefore, for public workers we estimate an OLS wage equation. Additionally, the wage equation is estimated separately for male and female since they have different earning profiles. This allows us to deal with different labor market conditions or differences in their reservation wages.

From an econometric point of view the estimation of equation (1) presents some issues which are commonly discussed in the returns to schooling literature. First, we do not have information about the true number years of education and then this leads to the usual measurement error problem which generates a downward bias in the OLS estimator. On the other hand, we lack information about ability which introduces an additional source of endogeneity. In this latter case, since ability is usually considered to be positively correlated with number of years of education, endogeneity leads to an upward bias. Therefore, the coefficient on schooling is an upper bound because it captures the effect of ability and schooling. Hence, these two traditional sources of endogeneity go in opposite directions and if these two sources of bias are of similar size these concerns are at least minimized.

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[7] We choose this period to maximize the significance of the *Crisis* dummy.

Empirical research in the returns to schooling field has dealt with these problems using different approaches (see Sanroman (2006) for a deeper discussion). Ideally, we would like to have a panel in order to control for time invariant unobserved ability and also a relevant (and reliable) instrument to tackle the measurement error problem. However, in this analysis we lack of both a longitudinal dimension and also an instrument and hence, we rely on both biases being of similar size. Finally, it is important to point out that: first, mitigating one of these problems could even increase the size of the bias; second, our ultimate objective is to generate a new adverse scenario and not to estimate the true impact of the return to schooling.

Estimating equations (1) and (2), we predict wages for private workers and unemployed individuals (between 14 and 60 years old) in the EFHU-2012 survey, assuming that the dummy *Crisis* takes the value of one for this selected sample. We also considered the change in the probability of employment. Therefore, in the crisis scenario we are considering that individuals receive a lower wage but also they have a lower probability of employment. Since we are also considering unemployed people a further assumption made is that unemployed individuals would get a job with a certain probability in the private sector. Then, we compute the household income using the predicted vector of earnings. As mentioned above we assume that the crisis impacts the earnings but not the employment status of public workers. In the case of individuals who are entrepreneurs, self-employed or inactive in the labor market, their wage rate remains unchanged.

First, we calculate the predicted change in wages using the employment probabilities from equation (1),

$$\Delta w_i = (\hat{w}_{c,i}\,\hat{p}_{c,i} - \hat{w}_i\,\hat{p}_i) \tag{3}$$

where $\hat{w}_{c,i}\,\hat{p}_{c,i}$ are the predicted wages and employment probabilities in the crisis scenario and $\hat{w}_i\,\hat{p}_i$ are the same variables in non-crisis period, that is, when the *Crisis* variable takes the value of zero. The term Δw_t is negative but its magnitude varies across individuals. As mentioned above, we assume that the crisis impacts the earnings but not the employment status of public workers. In the case of individuals who are entrepreneurs, self-employed or inactive in the labor market, their wage rate remains unchanged.

Then, we compute the household income that results after considering this negative earning shock. We define the predicted household income, which is the one that result from considering this negative earning shock, as follows,

$$predicted\ husehold\ income_h = household\ income_h + \sum_{i,h}^{N_h} \Delta w_{i,h} \tag{4}$$

where h denotes households and N_h is the number of household members at household h. The predicted income is equal to the actual household income plus the sum of the

negative shock to earnings that each household member would have received in case of a crisis.

Finally, we recalculate the financial burden using this predicted household income in (4) as follows,

$$New\ financial\ burden = reported\ financial\ burden * \left(\frac{household\ income}{predicted\ household\ income} \right) \quad (5)$$

As mentioned in previous section, self-reported financial burden is in discrete intervals. Therefore, in order to construct the "new financial burden" we opt to choose the mid-point of each interval. Alternatively, we assigned a random draw from the reported interval to each household, but results are similar. Based on the reported financial burden and the new financial burden, it is possible to compute a matrix of transitions to see how the households move from one financial burden category to another after the negative shock.

Because one of the main concern in a crisis is employment loss and the previous scenario only estimate a change in the employment probability as an additional stress test we allow for unemployment in the crisis. Based on the employment selection equation (1) we estimate the cutoff point of the employment probability for unemployed individuals in the 2002 crisis. Therefore, in this new stress scenario we assign to unemployment in the EFHU 2012 to all the individuals with an employment probability lower than the average employment probability of unemployed workers in 2002-2003.

With respect to our second objective, we construct a ratio of household debt over assets. We consider assets and not income since the former represents a stock similarly to debts which is also a stock[8]. The EFHU gathers information at the household level of housing debt and other types of debt not related to housing. Concerning housing mortgage debt, we multiply the numbers of month the household have to pay time the monthly payment. With respect to other debts, we consider the amount of other bank debts, debts with other type of institutions, debts with private, and the amount which left unpaid with the credit card. As household assets we consider the self-reported price of the house, other real Estate, vehicles, business, savings in the bank account and savings in other financial assets such as bonds, treasury bills, shares, etc. After calculating this ratio, we identify the over indebtedness households as those who have a ratio debt-assets above 60% following previous literature (Ruiz Tagle *et al.* (2013)). After that, we estimate binary models to find out which household characteristics are related to the fact of being over-indebted mainly focusing in labor market characteristics such as the number of unemployed household members. We perform as a robustness check the same analysis for the financial burden ratio using the ordered probit model.

[8] We also analyze the financial burden ratio.

V. RESULTS

Table 3 shows the results of the estimation of equation (1)[9]. The first three columns show the OLS estimates for the full sample and for males and females separately without controls by industry. We observed that the return to schooling is around 11% for both males and females while when we include additional controls it reduces to 10% approximately (column 4 to 6). Concerning the effect of the crisis on earnings, we observed that the 2002 economic downturn has lead to a decrease of 21% in the wage rates in the full sample case. Interestingly, when we split the sample by gender, these result only remains for males (35% decreases in earnings) while in the case of females the coefficient associated with *Crisis* dummy is negative but not statistically significant. The result is similar when adding controls. Moreover, the interaction of the *Crisis* dummy and years of schooling is positive and statistically significant for the male sample. That is, the crisis has relatively increase the private returns to education to high educated males and this could be related to the fact that high educated individuals are less affected by the negative shock compared with low skilled individuals who are more likely to experience an employment loss and a decrease in their wage rate after a negative shock in earnings.

TABLE 3

ESTIMATION OF THE MINCER EQUATION. ORDINARY LEAST SQUARED ESTIMATION

	All	Male	Female	All	Male	Female
Education	0.108***	0.113***	0.111***	0.100***	0.105***	0.099***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Crisis dummy (CD)	–0.211***	–0.345***	–0.047	–0.208***	–0.303***	–0.080*
	(0.021)	(0.030)	(0.029)	(0.037)	(0.065)	(0.048)
Education x CD	0.010***	0.020***	–0.003	0.006***	0.013***	–0.005
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Experience	0.021***	0.027***	0.019***	0.020***	0.025***	0.018***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience2	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	2.566***	2.555***	2.527***	2.757***	2.773***	2.794***
	(0.010)	(0.015)	(0.015)	(0.012)	(0.019)	(0.017)
Observations	209.645	108.329	101.316	209.645	108.329	101.316
R^2	0.271	0.275	0.275	0.292	0.297	0.297
Adjusted R^2	0.271	0.275	0.275	0.292	0.297	0.297
Control by department	Yes	Yes	Yes	Yes	Yes	Yes
Control by sectors	No	No	No	Yes	Yes	Yes
Control by sectors x CD	No	No	NO	Yes	Yes	Yes

Note: All regressions include a marital status dummy variables and also a binary variable that takes the value of one when the member is the household herad. * significant at 10%; ** significant at 5%; significant at 1%.

[9] We estimate the regressions without population weights. Their inclusion does not change the results. These results are available upon request.

The Heckman two stage procedure results are quite similar to the OLS estimates, which could be related to small selected sample bias (see Table 4.a). Table 4.b shows the fist stage of the Heckman methodology, that is, the probability of being employed. As expected, the correlation between employment and having kids at home is negative and statistically significant. Also, the correlation between employment and education is positive. In this case, the *Crisis* dummy impact both males and females negatively and significantly.

Table 5 presents the results of the estimation of equation (1) using quantile regression methods. For males, we observe that return to schooling increase slightly from around 10% in the first decile to 13% in the ninth decile. For females, there seems to be an increasing pattern. These results are in line with those in Sanroman (2006). We have to point out that in this case we find a negative effect of the *Crisis* dummy on the wage of female workers. However, the effect of the crisis is only negative and statistically significant for middles class female workers. We observe that the effect of the crisis is around a 30% reduction in the first 5 deciles and after the sixth decile it increases reaching a 40% reduction in the ninth decile.

TABLE 4A

ESTIMATION OF THE MINCER EQUATION - HECKMAN METHOD

	All	Male	Female	All	Male	Female
Education	0.104***	0.111***	0.108***	0.095***	0.103***	0.094***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Crisis dummy (CD)	–0.143***	–0.283***	–0.021	–0.132***	–0.219***	–0.034
	(0.023)	(0.040)	(0.031)	(0.037)	(0.069)	(0.048)
Education x CD	0.008***	0.019***	–0.003	0.005**	0.012***	–0.006*
	(0.002)	(0.003)	(0.003)	(0.002)	(0.003)	(0.003)
Experience	0.020***	0.026***	0.019***	0.019***	0.024***	0.017***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience^2	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	2,725***	2,666***	2,600***	2.937***	2.925***	2.931***
	(0.026)	(0.052)	(0.034)	(0.026)	(0.053)	(0.035)
Lambda mills ratio	–0.313***	–0.292**	–0.114**	–0.355***	–0.395***	–0.211***
	(0.046)	(0.131)	(0.047)	(0.046)	(0.129)	(0.047)
Observations	241,832	119,665	122,167	241.832	119.665	122.167
Control by department	Yes	Yes	Yes	Yes	Yes	Yes
Control by sectors	No	No	No	Yes	Yes	Yes
Control by sectors x CD	No	No	No	Yes	Yes	Yes

Note: All regressions include a marital status dummy variables and also a binary variable that takes the value of one when the member is the household herad. * significant at 10%; ** significant at 5%; significant at 1%.

TABLE 4B

FIRST STAGE OUTPUT OF HECKMAN'S METHOD

	All	Male	Female	All	Male	Female
Children [0,5] in hhd	–0.069***	–0.026***	–0.105***	–0.069***	–0.026***	–0.105***
	(0.005)	(0.009)	(0.007)	(0.005)	(0.009)	(0.007)
Children [6,13] in hhd	–0.094***	–0.019***	–0.110***	–0.094***	–0.019***	–0.110***
	(0.004)	(0.007)	(0.005)	(0.004)	(0.007)	(0.005)
Married - cohabit	0.224***	0.381***	0.029***	0.224***	0.381***	0.029***
	(0.007)	(0.013)	(0.010)	(0.007)	(0.013)	(0.010)
Head of household	0.462***	0.370***	0.232***	0.462***	0.370***	0.232***
	(0.007)	(0.012)	(0.011)	(0.007)	(0.012)	(0.011)
Education	0.036***	0.021***	0.056***	0.036***	0.021***	0.056***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Crisis dummy (CD)	–0.464***	–0.558***	–0.411***	–0.464***	–0.558***	–0.411***
	(0.013)	(0.020)	(0.018)	(0.013)	(0.020)	(0.018)
Experience	0.012***	0.011***	0.017***	0.012***	0.011***	0.017***
	(0.001)	(0.002)	(0.002)	(0.001)	(0.002)	(0.002)
Experience2	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.384***	0.651***	0.150***	0.384***	0.651***	0.150***
	(0.023)	(0.035)	(0.031)	(0.023)	(0.035)	(0.031)
Observations	241,832	119,665	122,167	241,832	119,665	122,167

Note: All regressions include control by department. * significant at 10%; ** significant at 5%; significant at 1%.

Figure 2 compares the distribution of the new vector of the (log) household real income predicted from the Heckman estimation with and without transfers, with its actual distribution. We observe a left shift in the distribution of the predicted household income (green and red line) which is mainly driven by the negative earning shock similar to the one experienced in the 2002 crisis. It is important to point out that this scenario is rather conservative since we are assuming that the crisis only has affected negatively wage earners but not self-employed individuals and pensioners. Figure 3 shows the density of the financial burden under this negative shock.

Table 6 shows the actual distribution of the monthly household's financial burden by quintiles. We compare the actual distribution with the one that result from assuming an adverse scenario as explained above and also a case without considering government transfers to household from social policies (conditional cash transfers and in-kind transfers). This latter case is motivated by the fact that during a recession we can think that government will attempt to reduce expenditures and one possibility is to cut transfers from social policies. Overall, we observed a slight shift to the right of the financial burden distribution when comparing column 1 with column 2 of each quintile. That is, in general, there is an increase in the proportion of household that reported a financial burden between 51% and 75% and also with more than 75%. For example, the percentage of households with financial burden greater than 75% increases from 3.7 to 7.75 (and to 8.76 with the elimination of the transfers). The highest raise

TABLE 5

ESTIMATION OF THE MINCER EQUATION. QUANTILE REGRESSIONS

	Q10		Q20		Q30		Q40		Q50 HECK_m_c1	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Education	0.101***	0.105***	0.098***	0.102***	0.101***	0.103***	0.104***	0.106***	0.108***	0.108***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Crisis dummy (CD)	–0.329***	0.044	–0.338***	–0.050	–0.304***	–0.087***	–0.300***	–0.074***	–0.299***	–0.039
	(0.097)	(0.063)	(0.049)	(0.034)	(0.032)	(0.032)	(0.020)	(0.027)	(0.028)	(0.027)
Education x CD	0.016**	–0.012*	0.018***	–0.004	0.015***	–0.001	0.016***	–0.002	0.017***	–0.005*
	(0.008)	(0.006)	(0.005)	(0.003)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)	(0.003)
Experience	0.021***	0.013***	0.021***	0.013***	0.023***	0.016***	0.024***	0.017***	0.026***	0.018***
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Experience2	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	2.039***	1.974***	2.357***	2.294***	2.485***	2.417***	2.572***	2.500***	2.648***	2.594***
	(0.023)	(0.041)	(0.018)	(0.025)	(0.014)	(0.019)	(0.014)	(0.019)	(0.011)	(0.014)
	Q60		Q70		Q80		Q90			
Education	0.112***	0.110***	0.115***	0.113***	0.120***	0.116***	0.127***	0.118***		
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)		
Crisis dummy (CD)	–0.318***	–0.035	–0.352***	–0.045*	–0.394***	–0.050*	–0.433***	–0.053		
	(0.029)	(0.032)	(0.030)	(0.027)	(0.034)	(0.030)	(0.050)	(0.035)		
Education x CD	0.018***	–0.004	0.022***	–0.003	0.025***	–0.002	0.029***	–0.001		
	(0.003)	(0.003)	(0.003)	(0.003)	(0.004)	(0.002)	(0.005)	(0.003)		
Experience	0.029***	0.021***	0.031***	0.022***	0.033***	0.023***	0.037***	0.026***		
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)		
Experience2	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***	–0.000***		
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)		
Constant	2.714***	2.676***	2.789***	2.766***	2.888***	2.882***	3.019***	3.069***		
	(0.012)	(0.014)	(0.014)	(0.017)	(0.019)	(0.019)	(0.024)	(0.026)		

Note: All regressions include a marital status dummy variables, a binary variable that takes the value of one when the member is the household head and controls by department. Number of observations: 108,329 for the male case and 101,316 for the female case.* significant at 10%; ** significant at 5%; significant at 1%.

FIGURE 2

DISTRIBUTION OF THE ACTUAL AND PREDICTED (LOG) HOUSEHOLD REAL INCOME

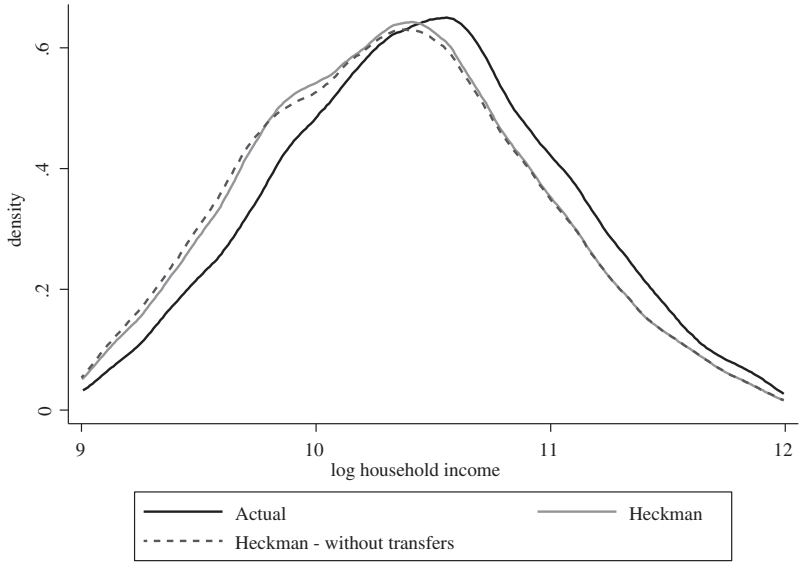


FIGURE 3

MONTHLY HOUSEHOLD'S FINANCIAL BURDEN ANALYSIS. HECKMAN. WITHOUT UNEMPLOYMENT

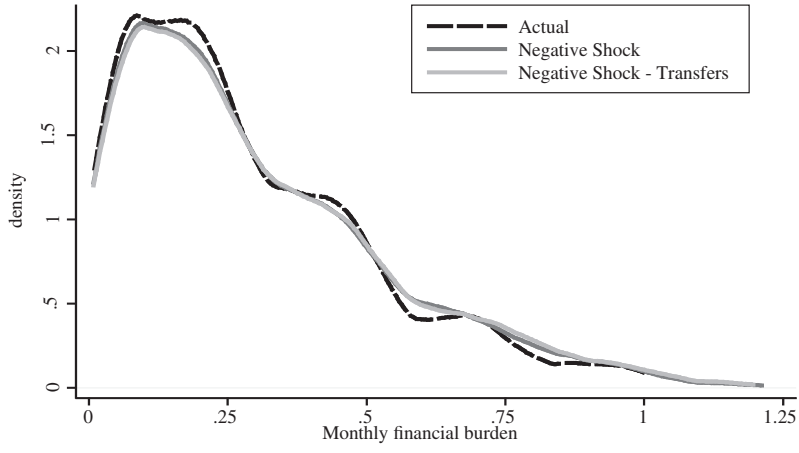


TABLE 6

ANALYSIS OF SELF-REPORT HOUSEHOLDS' FINANCIAL BURDEN. HECKMAN

	1st Quintile			2nd Quintile			3rd Quintile			4th Quintile			5th Quintile			Total		
	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers
To 25%	52.89	50.37	47.76	52.99	49.25	48.20	54.99	49.92	49.92	60.03	53.79	53.79	60.38	50.00	50.00	56.11	50.64	49.93
Between 26% and 50%	30.17	28.54	28.36	32.19	28.29	28.59	32.57	29.49	29.19	24.62	23.95	23.78	25.96	29.23	29.23	29.30	27.90	27.83
Between 51% and 75%	11.73	14.93	14.18	11.23	14.52	14.07	9.37	13.21	13.36	11.97	13.49	13.32	10.19	12.31	12.31	10.88	13.71	13.48
More than 75%	5.21	6.16	9.70	3.59	7.93	9.13	3.07	7.37	7.53	3.37	8.77	9.11	3.46	8.46	8.46	3.70	7.75	8.76
	Education Environment [0,6]			Education Environment [7,9]			Education Environment [10,12]			Education Environment >12			Total					
	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers			
To 25%	56.39	53.27	52.34	53.90	48.20	47.15	55.63	51.40	50.81	59.64	50.25	50.08	56.11	50.64	49.93			
Between 26% and 50%	28.35	26.79	27.10	30.27	29.34	29.10	30.08	25.58	25.47	27.84	30.31	30.15	29.30	27.90	27.83			
Between 51% and 75%	12.15	14.49	13.24	11.06	13.50	13.39	10.34	14.07	14.19	10.05	12.69	12.85	10.88	13.71	13.48			
More than 75%	3.12	5.45	7.32	4.77	8.96	10.36	3.95	8.95	9.53	2.47	6.75	6.92	3.70	7.75	8.76			

in financial risk is observed for households in the fifth quintile. Interestingly, when we also do not consider transfers (column 3), there is greater shift to the right, mainly, for the first quintile. We observe an important increase in financial risk of low income households when we remove the transfers. Furthermore, we present the distribution of financial burden by levels of education environment. The financial risk is the highest for households with education attainment between seven and nine years of schooling. The results show a quite similar picture. Despite the fact that there is an overall increase in financial risk because of the shock its magnitude is lower than in 2002.

We also estimate the transitions matrix for the case of the financial burden ratio after a negative shock by income quintile (see Table 7). The previous results remains, that is, we observe a mild increase in financial risk after the negative income shock.

The previous results can be explained by the reduction in household indebtedness from 28% at the beginning of 2004 to 16% in 2012. The public transfer plays an important role in the decline of the first quintile household indebtedness.

As mentioned above, one of the main concerns in a crisis is employment loss and the previous scenario only estimate a change in the employment probability. Therefore, as an additional stress test we allow for unemployment in the crisis. In this new stress scenario we assign to unemployment in the EFHU 2012 to all the individuals with an employment probability lower than the average employment probability of unemployed workers in 2002-2003.

Tables 8 and 9 show the results in this scenario. Table 8 shows that the percentage of households with financial burden higher than 0.75 increases 175% (from 3.71 to 10.19), and with financial burden between 0.5 and 0.75 increases 15%. The impact is the lowest for low income households because of public transfers that alleviate their financial situation. The households in the third and fourth quintile are the most affected by the loss of employment. Interestingly, the impact in financial burden is more even distributed across education categories. Additionally, Figure 4 shows the density of the financial burden under this negative shock with unemployment. As discussed above we find an increase in the percentage of households with financial burden higher than 0.75.

Table 9 shows the transitions matrix for the case of the financial burden ratio after a negative shock with loss of employment by income quintile. The previous results remains, that is, we observe an increase in financial risk after the negative income shock.

Finally, in Table 10 we analyze the determinants of being over indebted. When we analyze the debt assets ratio we find a negative and significant correlation with more than twelve years of education, age squared, paying the debt and occupant with owner permission. However, the correlation is positive and significant with having children at home, paid the home and being in quintiles 2 and 3[10]. When we analyze the burden financial ratio we find that few variables significantly explain it.

[10] Figure 5 shows the histogram of the debts-assets ratio.

TABLE 7

TRANSITIONS MATRIX

		Actual data																			
		1st Quintile				2nd Quintile				3rd Quintile				4th Quintile				5th Quintile			
		To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%
Heckman	To 25%	98.94	1.24	0.00	0.00	98.87	0.47	0.00	0.00	95.81	0.00	0.00	0.00	95.79	0.68	0.00	0.00	90.76	0.00	0.00	0.00
	Between 26% and 50%	1.06	83.85	3.17	0.00	0.85	86.05	2.67	0.00	4.19	80.66	1.64	0.00	3.93	87.67	4.23	0.00	7.96	83.70	0.00	0.00
	Between 51% and 75%	0.00	13.66	82.54	10.71	0.28	10.70	76.00	4.17	0.00	12.26	73.77	0.00	0.28	10.27	63.38	0.00	0.64	11.85	81.13	5.56
	More than 75%	0.00	1.24	14.29	89.29	0.00	2.79	21.33	95.83	0.00	7.08	24.59	100.00	0.00	1.37	32.39	100.00	0.64	4.44	18.87	94.44
Heckman - without transfers	To 25%	98.59	1.24	0.00	0.00	98.31	0.47	0.00	0.00	95.53	0.00	0.00	0.00	95.79	0.68	0.00	0.00	90.76	0.00	0.00	0.00
	Between 26% and 50%	1.06	78.26	3.17	0.00	1.41	83.72	2.67	0.00	4.47	79.72	1.64	0.00	3.93	87.67	4.23	0.00	7.96	83.70	0.00	0.00
	Between 51% and 75%	0.00	18.63	74.60	3.57	0.28	13.02	74.67	4.17	0.00	13.21	72.13	0.00	0.00	10.27	63.38	0.00	0.64	11.85	81.13	5.56
	More than 75%	0.35	1.86	22.22	96.43	0.00	2.79	22.67	95.83	0.00	7.08	26.23	100.00	0.28	1.37	32.39	100.00	0.64	4.44	18.87	94.44
Heckman + negative earning shock to public employees	To 25%	98.94	2.48	0.00	0.00	98.87	0.47	0.00	0.00	97.49	1.42	0.00	0.00	96.63	2.74	0.00	0.00	89.17	0.00	0.00	0.00
	Between 26% and 50%	1.06	83.23	11.11	0.00	1.13	84.65	5.33	0.00	2.51	74.53	6.56	0.00	3.09	73.29	4.23	0.00	9.55	75.56	3.77	0.00
	Between 51% and 75%	0.00	14.29	69.84	14.29	0.00	11.63	68.00	4.17	0.00	18.87	67.21	5.00	0.28	21.92	53.52	0.00	0.96	18.52	67.92	5.56
	More than 75%	0.00	0.00	19.05	85.71	0.00	3.26	26.67	95.83	0.00	5.19	26.23	95.00	0.00	2.05	42.25	100.00	0.32	5.93	28.30	94.44
Heckman - without transfers + negative earning shock to public employees	To 25%	98.59	1.86	0.00	0.00	98.02	0.47	0.00	0.00	97.49	1.42	0.00	0.00	96.63	2.74	0.00	0.00	89.17	0.00	0.00	0.00
	Between 26% and 50%	1.06	76.40	7.94	0.00	1.98	83.72	4.00	0.00	2.51	73.58	6.56	0.00	3.09	72.60	4.23	0.00	9.55	75.56	3.77	0.00
	Between 51% and 75%	0.00	21.12	65.08	10.71	0.00	12.09	66.67	4.17	0.00	19.34	65.57	5.00	0.00	22.60	53.52	0.00	0.96	18.52	67.92	5.56
	More than 75%	0.35	0.62	26.98	89.29	0.00	3.72	29.33	95.83	0.00	5.66	27.87	95.00	0.28	2.05	42.25	100.00	0.32	5.93	28.30	94.44

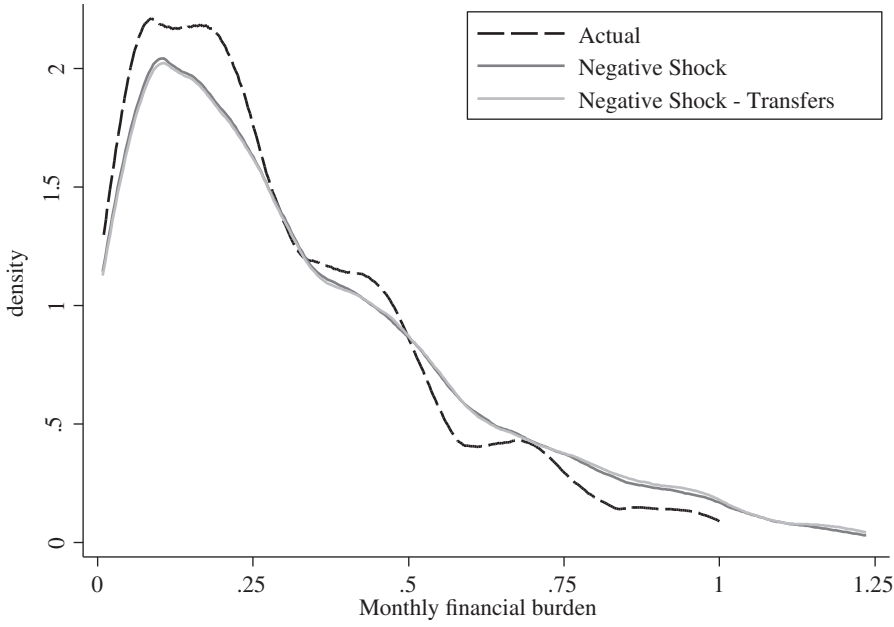
TABLE 8

ANALYSIS OF SELF-REPORT HOUSEHOLDS' FINANCIAL BURDEN. HECKMAN (WITH UNEMPLOYMENT)

	1st Quintile			2nd Quintile			3rd Quintile			4th Quintile			5th Quintile			Total		
	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers
To 25%	52.89	52.12	49.16	52.99	51.50	51.20	54.99	51.54	51.54	60.03	58.01	58.01	60.38	52.99	52.99	56.11	53.00	52.58
Between 26% and 50%	30.17	25.75	25.05	32.19	26.05	26.20	32.57	26.85	26.39	24.62	20.24	19.90	25.96	25.43	25.43	29.30	24.90	24.64
Between 51% and 75%	11.73	13.43	13.83	11.23	13.02	12.72	9.37	12.35	12.50	11.97	11.47	11.64	10.19	12.33	12.33	10.88	12.52	12.59
More than 75%	5.21	9.70	11.96	3.59	9.43	9.88	3.07	9.26	9.57	3.37	10.29	10.46	3.46	9.25	9.25	3.70	9.58	10.19
	Education Environment [0,6]			Education Environment [7,9]			Education Environment [10,12]			Education Environment >12			Total					
	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers	Actual	Predicted	Predicted - Transfers			
To 25%	56.39	53.68	52.66	53.90	49.88	49.42	55.63	52.67	52.44	59.64	57.17	57.17	56.11	53.00	52.58			
Between 26% and 50%	28.35	25.51	26.02	30.27	25.17	24.13	30.08	24.19	24.19	27.84	24.88	24.55	29.30	24.90	24.64			
Between 51% and 75%	12.15	13.15	12.54	11.06	12.94	13.29	10.34	12.67	12.79	10.05	11.04	11.37	10.88	12.52	12.59			
More than 75%	3.12	7.67	8.78	4.77	12.00	13.17	3.95	10.47	10.58	2.47	6.92	6.92	3.70	9.58	10.19			

FIGURE 4

MONTHLY HOUSEHOLD'S FINANCIAL BURDEN ANALYSIS. HECKMAN WITH UNEMPLOYMENT



VI. CONCLUSIONS

We analyze the first nationally representative financial household survey performed in Uruguay to study financial risk. We find that the debt level of Uruguayan households is low in international terms. We also simulate the impact of the finance of Uruguayan households of a negative income shock similar to the one experienced in 2002. Interestingly, we find that the financial risks are lower than in the past. This fact can be explained for the variability in risk variables (one limitation is that we do not observe a complete economic cycle) and the public transfers that alleviate the financial situation of poor households. In particular we observe a 28% reduction in household indebtedness from 2004 to 2012. A panel data survey is required to perform a better analysis. For example, with panel data we could understand and estimate risk and default transitions.

TABLE 9

TRANSITIONS MATRIX (WITH UNEMPLOYMENT)

		Actual data																			
		1st Quintile				2nd Quintile				3rd Quintile				4th Quintile				5th Quintile			
		To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%	To 25%	Between 26% and 50%	Between 51% and 75%	More than 75%
Heckman	To 25%	94.37	1.24	0.00	0.00	96.61	0.00	0.00	0.00	93.52	0.00	0.00	0.00	94.66	0.68	0.00	0.00	89.49	0.00	0.00	0.00
	Between 26% and 50%	4.58	77.02	3.17	0.00	2.82	77.67	1.33	0.00	5.63	78.30	0.00	0.00	3.93	84.25	4.23	0.00	7.96	82.09	0.00	0.00
	Between 51% and 75%	0.70	15.53	74.60	7.14	0.56	15.35	70.67	4.17	0.56	11.79	68.85	0.00	1.12	13.01	59.15	0.00	1.59	10.45	81.13	0.00
	More than 75%	0.35	6.21	22.22	92.86	0.00	6.98	28.00	95.83	0.28	9.91	31.15	100.00	0.28	2.05	36.62	100.00	0.96	7.46	18.87	100.00
Heckman - without transfers	To 25%	90.46	1.24	0.00	0.00	94.63	0.00	0.00	0.00	93.52	0.00	0.00	0.00	94.66	0.68	0.00	0.00	89.49	0.00	0.00	0.00
	Between 26% and 50%	8.48	71.43	3.17	0.00	4.80	76.74	1.33	0.00	5.63	76.89	0.00	0.00	3.93	84.25	4.23	0.00	7.96	82.09	0.00	0.00
	Between 51% and 75%	0.35	19.25	63.49	3.57	0.28	15.81	69.33	4.17	0.28	13.21	68.85	0.00	0.84	13.01	59.15	0.00	1.59	10.45	81.13	0.00
	More than 75%	0.71	8.07	33.33	96.43	0.28	7.44	29.33	95.83	0.56	9.91	31.15	100.00	0.56	2.05	36.62	100.00	0.96	7.46	18.87	100.00
Heckman + negative earning shock to public employees	To 25%	95.42	1.86	0.00	0.00	97.18	0.00	0.00	0.00	93.24	1.42	0.00	0.00	95.51	2.74	0.00	0.00	87.58	0.00	0.00	0.00
	Between 26% and 50%	3.52	76.40	7.94	0.00	2.54	75.81	2.67	0.00	5.92	71.23	3.28	0.00	3.65	71.23	4.23	0.00	9.87	73.88	3.77	0.00
	Between 51% and 75%	0.70	16.15	65.08	10.71	0.28	17.21	64.00	4.17	0.56	18.40	62.30	5.00	0.56	21.23	49.30	0.00	1.91	17.16	66.04	0.00
	More than 75%	0.35	5.59	26.98	89.29	0.00	6.98	33.33	95.83	0.28	8.96	34.43	95.00	0.28	4.79	46.48	100.00	0.64	8.96	30.19	100.00
Heckman - without transfers + negative earning shock to public employees	To 25%	91.87	1.86	0.00	0.00	96.61	0.00	0.00	0.00	93.24	1.42	0.00	0.00	95.51	2.74	0.00	0.00	87.58	0.00	0.00	0.00
	Between 26% and 50%	7.07	68.94	4.76	0.00	3.11	75.35	2.67	0.00	5.92	69.81	3.28	0.00	3.37	70.55	4.23	0.00	9.87	73.88	3.77	0.00
	Between 51% and 75%	0.35	21.12	58.73	7.14	0.00	17.21	62.67	4.17	0.28	19.34	62.30	5.00	0.56	21.92	49.30	0.00	1.91	17.16	66.04	0.00
	More than 75%	0.71	8.07	36.51	92.86	0.28	7.44	34.67	95.83	0.56	9.43	34.43	95.00	0.56	4.79	46.48	100.00	0.64	8.96	30.19	100.00

TABLE 10

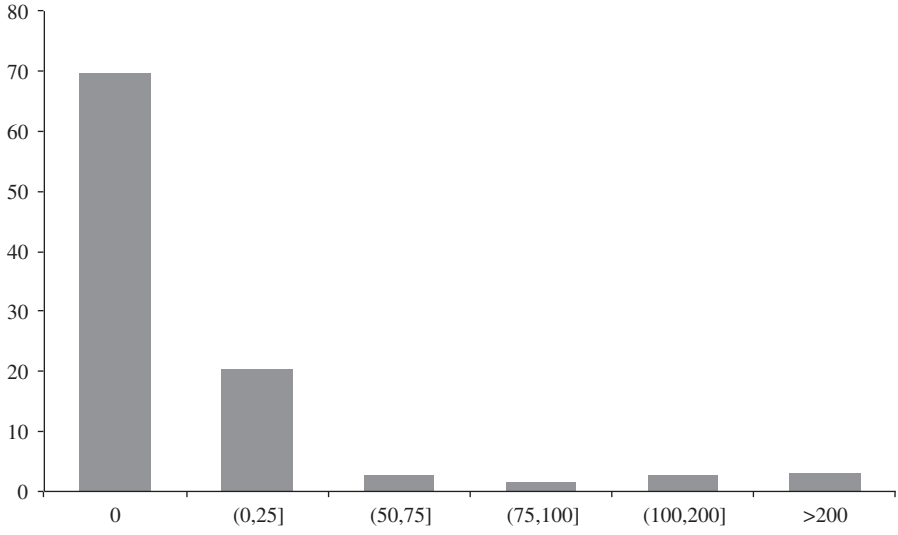
PROBIT AND BIPROBIT MODEL. OVER-INDEBTEDNESS HOUSEHOLDS

	Probit						Ordered probit			
	Debt/Assets >= 0.5	Debt/Assets >= 0.75	Debt/Assets >= 0.5 *	Debt/Assets >= 0.75 *	Financial burden >= 0.5	Financial burden >= 0.75	Financial Burden <0.25	0.25 <Financial Burden <= 0,5	0.5>Financial Burden <=0.75	Financial Burden >0.75
Education environment 7-9 years	0.021*	0.015	0.016	0.011	0.014	0.021*	–0.038	0.016	0.014	0.008
	(0.011)	(0.010)	(0.010)	(0.009)	(0.018)	(0.011)	(0.024)	(0.010)	(0.009)	(0.005)
Education environment 10-12 years	0.021*	0.014	0.013	0.010	0.004	0.015	–0.033	0.014	0.012	0.007
	(0.011)	(0.010)	(0.011)	(0.010)	(0.020)	(0.012)	(0.026)	(0.011)	(0.010)	(0.005)
Education environment >12 years	–0.019	–0.020*	–0.025**	–0.022*	–0.017	0.000	0.004	–0.002	–0.001	–0.001
	(0.013)	(0.012)	(0.012)	(0.011)	(0.024)	(0.015)	(0.031)	(0.013)	(0.012)	(0.006)
Head of household male	0.006	0.004	0.009	0.002	–0.035***	–0.003	0.038**	–0.016**	–0.014**	–0.008**
	(0.007)	(0.006)	(0.007)	(0.006)	(0.013)	(0.007)	(0.017)	(0.007)	(0.006)	(0.004)
Head of household age	0.002	0.002	0.000	0.002	–0.000	0.001	–0.002	0.001	0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.003)	(0.001)	(0.003)	(0.001)	(0.001)	(0.001)
Head of household age squared	–0.000**	–0.000***	–0.000	–0.000**	–0.000	–0.000	0.000	–0.000	–0.000	–0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Number of unemployed in hhd >0	0.011	0.010	0.004	0.001	0.016	0.016	–0.036	0.015	0.013	0.007
	(0.013)	(0.011)	(0.012)	(0.011)	(0.023)	(0.012)	(0.030)	(0.012)	(0.011)	(0.006)
Number of children [0,6]	0.014**	0.013**	0.012**	0.010*	–0.001	–0.002	–0.001	0.001	0.000	0.000
	(0.007)	(0.006)	(0.006)	(0.005)	(0.013)	(0.008)	(0.017)	(0.007)	(0.006)	(0.004)
Number of children (6,14]	0.022***	0.014***	0.019***	0.013***	0.001	0.006	–0.003	0.001	0.001	0.001
	(0.005)	(0.004)	(0.005)	(0.004)	(0.011)	(0.006)	(0.014)	(0.006)	(0.005)	(0.003)
Number of adults >=60	0.013*	0.011	0.006	0.009	0.018	0.011	–0.018	0.008	0.007	0.004
	(0.008)	(0.007)	(0.007)	(0.007)	(0.013)	(0.007)	(0.017)	(0.007)	(0.006)	(0.004)
Owner - paid the house	0.117***	0.054***	0.131***	0.075***	0.002	0.000	–0.050*	0.021*	0.019*	0.010*
	(0.010)	(0.009)	(0.010)	(0.009)	(0.021)	(0.013)	(0.026)	(0.011)	(0.010)	(0.005)
Owner - paying	–0.104***	–0.088***	–0.086***	–0.074***	–0.020	–0.000	0.032	–0.013	–0.012	–0.007
	(0.009)	(0.009)	(0.009)	(0.008)	(0.018)	(0.011)	(0.024)	(0.010)	(0.009)	(0.005)
Occupant with private paying owner permission	–0.033***	–0.028***	–0.030***	–0.025***	0.033	0.007	–0.020	0.008	0.007	0.004
	(0.010)	(0.009)	(0.009)	(0.008)	(0.020)	(0.012)	(0.027)	(0.011)	(0.010)	(0.006)
Occupant with dependency relationship + public permission	–0.024	–0.066*	–0.009	–0.048	0.066	0.016	–0.139**	0.058**	0.052**	0.029**
	(0.031)	(0.036)	(0.029)	(0.033)	(0.048)	(0.029)	(0.060)	(0.025)	(0.023)	(0.013)
Occupant without permission	0.037	0.042*	0.036	0.040*	0.017	0.016	0.022	–0.009	–0.008	–0.004
	(0.029)	(0.024)	(0.027)	(0.023)	(0.061)	(0.029)	(0.090)	(0.038)	(0.034)	(0.019)
Quintile 2	0.037***	0.028***	0.042***	0.026***	–0.011	–0.012	0.008	–0.003	–0.003	–0.002
	(0.011)	(0.010)	(0.011)	(0.009)	(0.021)	(0.012)	(0.028)	(0.012)	(0.010)	(0.006)
Quintile 3	0.030**	0.024**	0.032***	0.021**	–0.029	–0.014	0.028	–0.012	–0.011	–0.006
	(0.012)	(0.011)	(0.012)	(0.010)	(0.023)	(0.013)	(0.030)	(0.012)	(0.011)	(0.006)
Quintile 4	0.013	0.006	0.001	–0.001	0.004	–0.009	0.044	–0.019	–0.017	–0.009
	(0.013)	(0.012)	(0.013)	(0.011)	(0.025)	(0.014)	(0.033)	(0.014)	(0.012)	(0.007)
Quintile 5	0.037***	0.027**	0.029**	0.014	–0.010	–0.003	0.051	–0.022	–0.019	–0.011
	(0.014)	(0.013)	(0.014)	(0.012)	(0.028)	(0.016)	(0.037)	(0.016)	(0.014)	(0.008)
Observations	6.443	6.443	6.400	6.400	2.949	2.739	2.969	2.969	2.969	2.969
Pseudo R^2	0.198	0.155	0.209	0.161	0.044	0.050	0.025	0.025	0.025	0.025
Log likelihood	–1.648,51	–1.394,74	–1.520,30	–1.291,54	–1.175,73	–438.177	–3.031,42	–3.031,42	–3.031,42	–3.031,42
Control by department	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

* significant at 10%; ** significant at 5%; significant at 1%.

FIGURE 5

DEBTS-ASSETS RATIO HISTOGRAM



In the most adverse scenario, that replicates the 2002 crisis we estimate and 175% increase in the number of households with financial burden higher than 0.75. Despite this big increase, this group represents 10% of the population.

We find that some variables are correlated with the fact of being over indebted. However, when we analyze the burden financial ratio we find that few variables significantly explain it. Further research is necessary to understand better the determinants of the financial burden.

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THE IMPORTANCE OF FINANCIAL INSTITUTIONS FOR THE DEVELOPMENT OF THE BRAZILIAN AMAZON: AN APPLICATION OF THE SOCIAL ACCOUNTING MATRIX

LA IMPORTANCIA DE LAS INSTITUCIONES FINANCIERAS PARA EL DESARROLLO DE LA AMAZONIA BRASILEÑA: UNA APLICACION DE LA MATRIZ DE CONTABILIDAD SOCIAL

ANDRE CUTRIM CARVALHO*
Federal University of Pará

DAVID FERREIRA CARVALHO**
Federal University of Pará

Abstract

The fundamental purpose of this article is intended to measure the economic impacts that the regional financial institutions are providing along the chain of values of the productive activities located in the Brazilian Amazon and their impacts on economic activities through the Social Accounting Matrix. The main conclusion is that to break the status quo in the region, it is necessary to set a national regional development policy that favors the formation of vertically integrated production chains and a trade policy that encourages the export of most products value-added so that the benefits arising can be internalized in the Brazilian Amazon in the form of income and employment.

Keywords: *Financial institutions, Brazilian Amazon, Social Accounting Matrix.*

JEL Classification: *R00, R11, R15.*

* PhD Economics Professor, Faculty of Economics, Federal University of Pará, Belém, Pará, Brasil. E-mail: andrecc83@gmail.com

** PhD Economics Professor, Faculty of Economics, Federal University of Pará, Belém, Pará, Brasil. E-mail: david.fcarvalho@yahoo.com.br

Resumen

El propósito fundamental de este artículo es pretender medir el impacto económico que las instituciones financieras regionales están proporcionando a lo largo de la cadena de valor de las actividades productivas ubicadas en la Amazonia brasileña y su impacto en las actividades económicas mediante la Matriz de Contabilidad Social. La principal conclusión es que para romper el statu quo *en la región, es necesario establecer una política nacional de desarrollo regional que favorezca la formación de cadenas productivas integradas verticalmente y una política comercial que fomente la exportación de la mayoría de productos de valor agregado para que los beneficios derivados puedan ser internalizados en la Amazonia brasileña en forma de ingresos y empleo.*

Palabras clave: *Instituciones financieras, Amazonia brasileña, Matriz de Contabilidad Social.*

Clasificación JEL: *R00, R11, R15.*

1. INTRODUCTION

In Brazil, the discussion on the social repercussions generated by the deepening of the regional economic differences, in the latest years, is restricted to convergence studies about the federated units' per capita incomes, on polarization reversion and, more recently, about the possibility of local development through the organization of productive chains and, the so called, local productive arrangements.

In this direction, the studies that deal with the question of regional development's financing are relatively scarce in Brazil, remember Amado (1999). The debate on the regional question always had as main focus the regional disparities associated to the asymmetries of the product's real variables, the income and the employment, when the performance of periphery regions (Amazon and Northeast) is compared to the economic center (Southeastern). For Cardim de Carvalho *et al.* (2001), "the interference of the monetary and financial variables, in the regional question's quarrel, was duly considered just a few times".

However, the articles of Dow (1992) and Chick (1994) came to motivate the theoretical debate about the importance of the currency and the banking system for the regional development. Amado (1999), for instance, admits that the scarcity of financial analysis in the scope of the regional economy is partially due to the adoption of an inadequate theoretical financing reference to approach the financial dynamics and its impacts on the regional production apparatus. The following reasons for such behavior can be identified:

I) The neutral function of the currency as mere way of exchanging goods;

II) The neutral function of the financial sector as simple financial intermediary between superavits agents (savers) e deficits agents (investors);
III) The function of the Central Bank as mere sanctioned of the currency in course forced to passively accommodate the real aggregate demand.

Thus, a question must guide the discussion of the present article: which should be the most appropriated financing standard of the regional development to overcome the limited capacity of financing strategic projects from the periphery regions of Brazil? which would be the most appropriated model? A regional financial system part of the national financial system, formed by a network of regional bank agencies; or a national financial system model with a wide network of agencies distributed throughout the national territory?

For the conventional theory of the borrowed funds, the formation of a national financial system can create convergent trajectories of economic development between the developed dynamic center and the delayed dependent periphery. This conception is based on the primitive period of the financial system when, supposedly, the "financial" flows equal the savings (deposits) to the investment (loans), as the economists of the orthodox side think.

However, nothing assures that this can really happen, because if the financing logic of the investments is of the market, such national financial model with limited level of regional integration, besides the absence of positive externalities and public development banks, could deepen even more the regional inequalities due to, especially, the advanced stage in which the current financial Brazilian system is[1].

Similarly it could be argued that an integrated financial model could be much more advantageous than a regional financial model – mainly due to the efficiency of the organizational and management structures, the positive externalities from technological, financial and operational innovations and the earnings from scale and scope economies – as it could provide, from the financial center where the headquarters of banks operating in the peripheral economy are located, a greater ability to finance investment for productive activities from peripheral regions.

However, although this possibility exists, the necessity of consolidating a national pattern of regional financial development, in developing economies, cannot discard the importance of the planning and regulating actions of the State, particularly in regard to the support needed to overcome the delay of the peripheral economies.

According Amado (1999), in such circumstances, the emptying of financial flows could harm the constitution of the "revolving fund" to finance by Keynes, as there would be a trend of declining bank deposits levels in agencies of the underdeveloped areas of the periphery. In the case of Brazil, the institutional definition of the national standard of funding for regional development must consider, besides the current

[1] In the fifth stage of the banking system's historical evolution, besides the consolidation of the bank deposits generators of reserves and credit, the presence of the bank currency as one of payment, the development of loans between banks in the interbank market and the central bank's presence admitting the role of the lender of last instance, the banks start to manage the negotiation of debts. See Chick (1994).

advanced stage of public and private financial institutions historical development, the republic entities' interests and its ways of governability and governance.

This article is organized into five sections, including this introductory section, as follows: the second section presents the methodological aspects that will be used for the development of this Article; the third section discusses financial institutions and its economic impacts in the Brazilian Amazon; the fourth section presents an analysis of the results of the implementation of the Social Accounting Matrix; finally, have the final considerations presented in the sixth and final section of the work.

2. METHODOLOGY: RESEARCH METHOD

The methodological specification is a mandatory part of academic research to adopt the scientific method; however, we must distinguish the method of approach of mentioned research methods. The method of approach with regard to the philosophical affiliation and the level of abstraction of the phenomenon studied, as research methods or research procedures consist of concrete steps of research and use of appropriate research techniques.

In the social sciences in general, it must be a methodological constraint: that is the need for confrontation of thought reality, abstracted from concrete, with empirical reality, that is, one that is perceived by our senses. In turn, the practical knowledge is subject to the need for immediate connection with reality to which they refer. Therefore, the theoretical research, unlike the empirical research – while the research method based on primary data from field surveys or even collection of secondary data – the research method has more to do with the method of exposition of ideas: if deductive or inductive.

In the present case, the approach adopted follows the hypothetical-deductive method in that it combines the deductive method, from the theoretical framework built with the inductive (empirical) method in that it uses the basic matrix data to test the central hypothesis of the economic impacts that the chain of non-metallic mineral sector in the economy because of the North Region of Brazil.

3. FINANCIAL INSTITUTIONS AND ITS ECONOMIC IMPACTS IN THE BRAZILIAN AMAZON

In the Brazilian case and elsewhere in Latin America, experience has shown that, if there is no creation of public financial institutions of pro-economic development, to work within a long term view of strategic planning, the possibilities of a national underdeveloped economy to solve the problems of inter-sectoral or inter-regional transfer of funds to delayed sectors or regions through the spontaneous development by the exclusive way of the financial market will become very scarce. This is not to deny the importance that has had the capital and credit markets as the diversification of resources, including preventing waste of personal savings.

The theoretical construction of Gurley and Shaw (1960) innovated on the genesis of financial market's structure and its impact on the operation of the economic system. Accordingly, Fray (1961):

> They had the merit to associate the problem of the economic development to the development of the financial system; to watch the importance of the creditor's risk on the structure of the financial market; and to transfer attention from interest rates to the quantitative and qualitative dimension of the demand and search for capital.

However, author as Gurley and Shaw (1960); Hirschman (1961) associate the financial development only to the balanced economic development, not to unbalanced economic development. Among the balanced economic development of concepts stands out the one in which it is supposed an investment policy capable of presenting a balanced sectoral growth of various industries simultaneously in a region in order to capture the external economies, as highlighted by Scitovsky (1969).

Nevertheless, changes in the production and distribution structure, as well as technological innovation, induced by the dynamics of the economic system, have repercussions on the structure of the financial market, especially as the private and public sectors, while important sectors for development in terms of income generation and employment, play important roles in the financial market, especially when the financing of investments is seen as the result of the confrontation of supply and demand in the financial market. In addition, register the dynamics of economic and financial systems is subject to uncertainty that produces certain changes in the structure of the financial market.

The organization of a modern financial market, comprising the credit and capital markets, enables the domestic savings to be risen to a certain level of the gross domestic product of an economy. Gurley and Shaw (1960) note that an efficient financial market supposedly allows scarce saving is applied in an excellent way, among the various areas of alternative investment, so that the economy's pace of growth is made at a higher rate than that where it would be an inefficient financial organization. Indeed, an incomplete national financial system is an obstacle to sustainable development. This brings into focus the effects of the financial market structure on the dynamics of regional economic system.

In the neoclassic models, the financial market is basically summarized to the market of borrowed funds and, thus, is defined as the locus where it is found the search and the demand of payment ways needed to cross the past time period between the decisions of agent's expenses of productive and consumption investment, and the formation of the monetary incomes of the families, remember Fray (1961).

In this view, on the supply side, the main funding sources of loanable funds are: current savings generated in a given period; divestment; dishoarding liquid; and net loans of additional banks. In contrast, the search for "funds" available can be composed of: funds for spending in the production of fixed capital investments or working capital; funds for hoarding; and funds for the expenditure of consumption, individual or collective, as well as current income.

In this neoclassical definition of a financial market, the above classification is shown somewhat arbitrary, since the self-financing problems and the importance of non-bank financial institutions are ignored, apart from the fact that the design of loanable funds theory proves to be a static approach ex post. Therefore, such a situation is a static concept because in dynamic terms would be difficult to separate the demand and the overall supply of components, any one of them for a given type of individual.

Moreover, it is an ex post concept because it is evident the attempt to specify in detail the supply and demand equilibrium position of loanable funds theory, in terms of real variables, reflecting the market clearing, i.e. equality between saving and business investment and equality of the supply of bank credit and the demand for loans in household consumption. Fray (1961) says:

> Starting from a classification of the demand for credit by customers, also with little bit of arbitrariness, defines the financial market in other way, in dynamic terms, considering all active individuals who make decisions on the financial market: 1) companies; 2) families; banks and credit institutions; 3) other financial institutions; and public banks. These categories may take a mixed financial position of applicants and suppliers of funds in the financial market, including involving the self-financing.

The structure of the financial market therefore should be characterized in their quantitative and qualitative aspects. The first group has the number of active individuals in the market, the dimensions of the activities they perform, and the number and volume of securities "primary" and "secondary". In the second group, figure types of financial institutions (monetary financial institutions and non-monetary), bond and how the stock market reacts to economic activities. In the third group, finally, are the other private financial institutions and banks and public funding agencies

Fray (1961), when considering the accumulation of capital in the form of investments that allows technical progress act, in the sense of generating economies of scale and increasing production capacity capable of causing profound changes in the productive structure, contributes to the acceptance of a standard unbalanced development as advocated by Hirschman. The unbalanced development releases, in turn, driving forces that trigger a sequence of inductive imbalances in economic activities of the various supply chains of an economy.

In turn, the configuration of a development pattern of financial savings also evolves over time. In a first step of the development of a financial system, families and companies seek financial intermediaries only to raise their capital-money in the financial movement sphere. In the second step, it is the financial intermediaries that seek credit demanding customers and loans are given based on criteria of profitability, liquidity and applications' risk and not only by their social or developmental projects. The access to resources from financial institutions is determined by the guarantees that the borrower can provide to the creditor, which means that, in general, actors who are already established in areas of higher profitability and can offer "safer" applications are favored.

In a developing economy, such as Brazilian, a significant parcel of many commercial banks and multiples' resource is directed to financing the families' capital goods and the working capital of enterprises, and less to the financing of investments in new activities or key strategic sectors for development. In the specific case of small companies, the solution in a greater or lesser extent has been the establishment of a specific financial intermediation that is disconnected from the formal financial market.

Alternatively, for strategic investments in productive sectors and economic and social infrastructure, it has been directed to public funds or public-private partnerships. The elements highlighted here will anchor the empirical analysis of the indicators from the Social Accounting Matrix.

3.1. Methodology for application of the Social Accounting Matrix

The construction of the Social Accounting Matrix is made from the Input-Output Matrix developed by Leontief (1966; 1970). In this work, however, only take place applying the model from the Social Accounting Matrix built by Santana (2004). In general lines, the Input-Output Matrix is an analytical tool which has been widely used in the inter-sectorial analysis. The economic theory tries to explain the transactions and economic relations existing in a market economy in terms of the cause and effect interactions between endogenous and exogenous variables.

In classical models, the trajectories of transactions of intermediate goods between sectors occur between two variables, but the individual economic transactions are too numerous and complex to be described in all its particulars, but it is possible to reduce them to a number of variables and ordering, classifying and adding them into groups. This is the methodology used by the input-output analysis to favor the domain of economic theory on the empirical facts with which the theory is concerned with every real situation.

To do this, we must understand that economic transactions are grouped into sectors of production, distribution, transport and consumption that are arranged in a double-entry matrix containing horizontal lines and vertical columns. The values of horizontal rows in the matrix show the distribution of the sales of production for each sector, according to the destination, among all sectors of the economy.

The values of the vertical columns of the matrix show the distribution of purchases of inputs needed in each sector, according to the source, among all sectors of economy. The element that appears in a cell, where the *i*-th row and the *i*-th column represents the value of production of sector *i* that is absorbed as input by sector *j*. In any cell, as the value in a row is the same value of a column, the production of each sector is also input of another, hence the input-output description.

However, despite the recognition of the importance of the input-output model, the results obtained from the application of the original models by Leontief input-output, or input-output model modified by Miyazawa (1966), may underestimate the impacts of activities that comprise the economy of the Brazilian Amazon. Indeed, the results of the Input-Output Matrix have shown relevant when it comes to estimate the multiplier effects of the product, income and employment in an economy.

Authors as Bernat and Johnson (1991) note that when it comes to measuring the productive effects back and forth of the activities, the Input-Output Matrix not directly incorporate the economic flows models that depart from productive activities for the production and these factors for institutions (households and government), and neither include in full the feedback of relations arising in final demand for goods and services.

To avoid this problem, new matrices generation was constructed by Stone (1985) "more disaggregated and consistent with the macroeconomic analysis of a country or region, in order to allow an appropriate structure to the circular flow of any market economy at national or regional contexts".

These are the reasons that justify the use of Social Accounting Matrix to analyze not only the global multiplier effects of the sector, but also the chaining effects of backward and forward Financial Institutions services on the production structure of the Brazilian Amazon.

3.2. Data sources

The database to measure the effects of the product multipliers, income and employment, as well as the effects of chaining (linkages) back and forward generated by financial institutions in the Amazon is the Input-Output Matrix of Brazilian Amazon 1999, which was prepared by Guilhoto and Sesso (2005) as a product of the agreement between the Bank of the Amazon (in Brazil called Banco da Amazônia or BASA) and the Institute for Applied Economic Research (in Brazil called Instituto de Pesquisa Econômica Aplicada or IPEA). The used methodology took as reference the new system of national accounts that has been used in Brazil since 1990.

The close connection of chain effects concept in the production process with Social Accounting Matrix is known. However, the concept chain effects, which is essentially a dynamic concept, can be used in a very mechanical way when it interprets the indicators derived from a Social Accounting Matrix without the appropriate restriction, as this is an analysis of input-and output-and, therefore, from synchronous nature.

It is known, consequently, that this is a problem that has hampered the understanding in cross-section or panel analysis, of the extension of dynamic effects in the production chain. The technical-economic forces that facilitate the achievement of the first steps can block the occurrence of the following, making a somewhat extended deployment of the chain effects due to the observed fact to "rely more than usually on public policy in the new process of industrialization", as Hirschman (1961).

3.3. Hypotheses for the model Social Accounting Matrix

The accounting system recorded by the double entry method, applied in the construction of Input-Output Matrix, allows the Input-Output Matrix reveals the economic structure of a regional economy from trade flows linking every branch and industry in a particular industry all others. Nevertheless, both the Input-Output Matrix as the Social Accounting Matrix is subject to some general assumptions and other specifics described below:

I) The hypothesis that the technical coefficients of these matrices are fixed. This means to assume that the technical coefficients do not change in the short term and therefore, there is no substitution of production factors when their relative prices change;
II) The hypothesis of the economy sectors aggregation. This implies that there may be errors on aggregation when the industries of a productive sector are combined. To avoid this problem, it is admitted that enterprises located in an industry produce the same kind of product and that the industries located in the same sector are homogeneous and different from the other industry sectors. This problem is mitigated as the economic structure can be presented in a more disaggregated way, with a larger number of economic activities;
III) The hypothesis of constant returns to scale to all sectors of the economy in general. This means that if the inputs vary in the same proportion, *k*, the production varies exactly alike, in the same proportion.

Beyond these basic hypotheses, the Social Accounting Matrix presents two others that are needed so a regional economy structure is appropriate. One is that the economy operates with idle capacity. This implies that an unexpected demand increase can be answered, at the same cost levels, by increasing the production scale.

Another hypothesis, a Keynesian, is that the market for goods and services are set via quantity. It means that the market disproportions for goods and services are revealed by an involuntary stock accumulation or not accumulation. Finally, there is the neo-keynesian hypothesis of institutional price rigidities due to menu costs, the externalities and information asymmetries. "As a result, the prices of goods of this regional economy remain fixed, at least in the short term", remember Mankiw (1992).

Based on the hypotheses set, the Social Accounting Matrix will be used to capture the effect on chain back and forth, as well as the effects of exogenous injections, by product multipliers of income and employment to the Amazon Brazilian economy.

3.4. Model structure of the Social Accounting Matrix

A Social Accounting Matrix is structured using as a base the Input-Output Matrix. In fact, as noted by Pyatt and Round (1979), the Social Accounting Matrix is structured linking to demand matrix for intermediate goods (inputs) to demand matrix for final goods representative of the private and public consumption, private and public investment and exports and imports and the corresponding payments to the factors production (value added). Similarly to the Input-Output Matrix, the structure of Social Accounting Matrix is represented by a general matrix formed by a set of double input cells. The representative of a regional economy Social Accounting Matrix, as well as technological matrix, is the matrix of regional accounts separated by institutions or economic agents.

The Social Accounting Matrix is a square matrix in which the sum of lines and the sum of the columns must be equal. Analyzing The Social Accounting Matrix, we have the rows and columns represent, respectively, the revenue and expenditure of economic agents and their values are accounted for in accordance with the method of double entry.

Therefore, Social Accounting Matrix is constructed by a square table in which each cell (*i, j*) defines a particular transaction or a transfer within the economy. Thus, the lines indicate the destination of the flows of accounts and columns indicate the origin of flows of the same accounts, in which case an input a value is revenue (sales) sector *i* arising from the payment (purchases) made by the sector *j*; or alternatively spending sector *j* (purchases) paid to the sector *i* (sales).

Table 1, for example, presents a social accounting matrix model compatible with a general equilibrium model of a given regional economy. In this square matrix representative of the Social Accounting Matrix, the values of each row and column is gathered in the same cell, although they represent separate accounts, define the method of double entry that revenue expenditures are equal. For purposes of simplification, it shows the circular flow diagram (monetary and real) variables. In the basic structure have the following accounts endogenous and exogenous.

A) Endogenous accounts:
(1) Production activities.
(2) Institutions.
(3) Value Added.

B) Exogenous accounts:
(4) Liquid Tax (gross taxes minus subsidies and transfers).
(5) Rest of the World (exports, net income sent imports).

TABLE 1

BASIC STRUCTURE OF THE SOCIAL ACCOUNTING MATRIX

Expenses / Revenues		Activities	Production Factors		Institutions			Rest of the Word
		(1)	Labor (2)	Capital (3)	Households (4)	Government (5)	Capital (6)	(7)
Activities	(1)	Intermediate Goods			Private Consumption	Government Consumption	Investment Brutal Fixed Capital Formation	Exportation
Production Factors								
Labor	(2)	Wage						
Capital	(3)	Profit						
Institutions								
Households	(4)		Wages	Profits		Transfers and Subsidies		Liquid Income Extra
Government	(5)	Indirect Tax			Indirect Tax			
Capital	(6)				Private Savings	Government Savings		
Rest of the World	(7)	Importation				Reservs		

Source: Made by the authors.

The Social Accounting Matrix comprises three different streams:

(I) Of productive activities, which correspond to the market transactions of goods and services, generating flows of nominal payments and in return the actual flows of goods and services carried out between economic agents;
(II) Of the institution that encompasses all consumers spending made by families and governments and investment expenses incurred by the companies (Brutal Fixed Capital Formation);
(III) Of the added values which involve transactions in the production factor market, corresponding to monetary remuneration of these factors (wages and profits) as real consideration for the services rendered by the same factors (labor and capital); and
(IV) The net tax is the gross total taxes less transfers and subsidies granted by the government;
(V) The rest of the world that matches the flow of exports, imports and liquid income sent.

Suppose be given an exogenous stimulus to productive activities, they respond to such stimulus generating the income corresponding to the remuneration of production factors (labor and capital) that constitutes the value added (in the form of wages and profits); that income generated, in turn, to be passed on to social institutions, is spent on consumer goods by households and estate investments by governments and companies, finished goods produced by these productive activities, then proceed to close the circular flow.

Therefore, it can be said that the circular flow of a regional economy works as follows: stimulating productive activity generates added value that determines the distribution of income of the institutions that income that defines the structure of spending on goods and services that stimulate the back productive activities and so on.

In fact, it is the theoretical basis Keynesian and extensions that support the Social Accounting Matrix model as the dynamics of this model has reference to the principle of aggregate demand. Therefore, it can be said that the Keynesian model based on Social Accounting Matrix has a strong adherence to the dynamics of regional development, as it is guided in stimulating the structuring and development of productive chains whose determination depends on effective demand.

3.5. The algebraic model of the Social Accounting Matrix

The Social Accounting Matrix can be presented in a model consisting of algebraic equations, expressed in matrix form, involving all elements of the model. In the terms, the Social Accounting Matrix of the regional economy may be so specified as:

$$\begin{aligned} X_a &= t_a X_a + t_c R + Y_a \\ X_v &= t_v X_a \\ X_i &= t_r X_v \\ E &= t_e X_e + t_i X_v \end{aligned} \tag{1}$$

Or better:

$$\begin{bmatrix} I - t_a & -t_c & 0 \\ 0 & I & -t_r \\ -t_v & 0 & I \end{bmatrix} . \begin{bmatrix} X_a \\ X_i \\ X_v \end{bmatrix} = \begin{bmatrix} Y_a \\ Y_i \\ Y_v \end{bmatrix}$$

The method to solve this model of Social Accounting Matrix is the same used for the Input-Output Matrix and the basic equation representing the final result is given by:

$$X = (I - A)^{-1} Y = M_g Y \tag{2}$$

where:

X_a = is the product vector of productive activities;
X_i = is the vector of institutional income;
X_v = is the remuneration production factors' vector;
$(I - A)^{-1}$ = is the matrix of global impacts;
I = is the identity matrix;
A = is the technologic matrix;
Y_a = is the vector of exogenous income of productive activities;
Y_i = is the vector of exogenous institutional income;
Y_v = is the vector of value added exogenous.

3.6. Decomposition of multipliers of the Social Accounting Matrix

The partitioned Social Accounting Matrix, containing only the endogenous accounts and indicating the average propensity to spend, is structured as a A matrix with size $(n + m + p, n + m + p)$ obtained from the division between the sector values contained in each column by the corresponding value of total expenditure, such that:

$$A \begin{bmatrix} Y_a \\ Y_i \\ Y_v \end{bmatrix} = \begin{bmatrix} X_a \\ X_i \\ X_v \end{bmatrix}; \qquad A = \begin{bmatrix} t_a & t_c & 0 \\ 0 & t_i & t_r \\ t_v & 0 & 0 \end{bmatrix}$$

In this partitioned matrix of the Social Accounting Matrix, we have:

t_a = matrix of input-output coefficients with dimension (n, n);;
t_c = matrix of dimensions costs coefficients (n, m); ;
t_r = matrix of institutional dimension transfer coefficients (m, p);;
t_v = matrix of added dimension value coefficients (p, n);
m = in the number of endogenous institutions;
n = is the number of productive activities;
p = is the categories number of added value.

The derivation of the partitioned matrix has as starting point the basic matrix of Leontief:

$$X = AX + Y \tag{1}$$

Or:

$$(I - A)X = Y$$

$$X = (I-A)^{-1}Y = M_g Y \tag{2}$$

$$X = M_g Y \tag{3}$$

The above expression represents the sector income of the endogenous activities as a result of injections in X multiplied by the matrix of the global effects. The A matrix above, can be partitioned into two matrices, represented by B and C, so that: $A = B + C$.

The matrices B and C can be written as follows:

$$B = \begin{bmatrix} t_a & 0 & 0 \\ 0 & t_i & 0 \\ 0 & 0 & 0 \end{bmatrix}; \qquad C = \begin{bmatrix} 0 & t_c & 0 \\ 0 & 0 & t_r \\ t_v & 0 & 0 \end{bmatrix}$$

The matrices B and C are derived from the matrix or the matrix of average propensity to spend or matrix of technical coefficients. Based on this partition, the basic equation of Leontief can be modified as follows:

$$X = AX + Y \qquad \text{(Leontief Basic Matrix)}$$

$$X = (A + B - B)X + Y \tag{4}$$

$$X = (A - B)X + BX + Y$$

$$X - BX = (A - B)X + Y$$

$$(I - B)X = (A - B)X + Y$$

$$X = (I - B)^{-1}(A - B)X + (I - B)^{-1}Y \tag{5}$$

Making:

$$D = (I - B)^{-1}(A - B) = M_{ai}C$$

And replacing in (10), we have:

$$X = DX + (I - B)^{-1}Y \tag{6}$$

This is the first interactive movement of the matrix process. Multiplying the equation (6) by D, we have:

$$DX = D^2X + (I - B)^{-1}DY \tag{7}$$

Replacing the equation (7) in equation (6), we have:

$$X = D^2X + (I - B)^{-1}DY + (I - B)^{-1}Y$$

$$X = D^2X + (I - B)^{-1}Y + (I - B)^{-1}DY$$

Putting in evidence the common factors in Y function, we have:

$$X = D^2X + (I + D)(I - B)^{-1}Y \tag{8}$$

This is the second movement of the interactive matrix process. Multiplying the equation (7) by D^2 and replacing (8) in (7) and then isolating the value of Y, we have:

$$X = (I - D^3)^{-1}(I + D + D^2)(I - B)^{-1}Y \tag{9}$$

This is the third and final movement of the interactive matrix process. Naming the effect-transfer matrix by M_{a1}, the cross-effect matrix by M_{a2} and the circular-effect matrix as M_{a3}, we have:

$$M_{a1} = (I - B)^{-1}; \qquad M_{a2} = (I + D + D^2); \qquad M_{a3} = (I - D^3)^{-1}$$

The global multiplier (M_g) is given by the product of the three above mentioned multipliers, so as:

$$M_g = M_{a3}M_{a2}M_{a1} \tag{10}$$

Replacing (10) in (2), we have the Leontief's fundamental equation changed in:

$$Y = M_{a3}M_{a2}M_{a1}Y = M_gY \tag{11}$$

These three multipliers, created by Pyatt and Round (1979), represent the following effects:

I) The direct and indirect effects from the transfer between activities from the same account set, therefore called by transfer-effect (M_{a1});
II) The effects from the transactions between different account blocks, therefore called crossover-effect (M_{a2}); and
III) The effects from the transactions between blocks, therefore called circle-effect (M_{a3}).

An alternative model was developed by Stone (1985) that, unlike the model by Pyatt and Round (1979), presents his model with four additive components. This additive equation is derived from three substitution operations which development can be found at Santana (2004).

$$M_g = I + (M_{a3} - I) + (M_{a2} - I)M_{a1} + (M_{a3} - I)M_{a2}M_{a1} \quad (12)$$

where:

I = is the matrix of initial impulses;
$(M - I)$ = it is matrix liquid-transfer effect Stone;
$(M - I)M_{a1}$ = it is cross effect matrix Stone;
$(M - I)M_{a2}M_{a1}$ = it is the matrix of cross-effect liquid Stone.

The Stone-transfer effect matrix allows one to calculate the indicators that capture the input-output transfer effects between productive activities and matches the array of global effects that captures inter-sectoral relations (Leontief Basic Matrix).

On the other hand, the cross-effect matrix Stone captures the economic impacts that result from the interactions that occur within and between the three accounts blocks of endogenous productive activities and the added value between value added and institutions and finally between institutions and productive activities. Finally, the matrix of circular effects captures the effects of exogenous stimulus in productive activities that are transmitted to the added values and for these institutions and their return to productive activities, closing the cycle. Hence, the importance of matrix decomposition of overall effects of Social Accounting Matrix remade in the three mentioned.

4. ANALYSIS OF THE RESULTS OF APPLYING THE MODEL OF THE SOCIAL ACCOUNTING MATRIX OF THE BRAZILIAN AMAZON

When the Social Accounting Matrix is analyzed it is not clear the concept of Financial Institutions, so it follows some clarification. Financial Institutions comprise

a group of banking institutions and non-bank providers of financial services. The banking financial institutions develop fundraising activities inherent to the surplus agents and applying for loans or financing the deficit agents.

The gap of resources given by the value of the collection and the application corresponds to the profit of the banking financial institution due to one of its functions is to provide information. A second important function concerns the performance of banking financial institutions to reduce risks because lenders want to get more to take risks. A third function of banking financial institutions is to provide the issuance of any claims about themselves in order to satisfy the demand of those rights by the lenders.

In fact, the distinction between bank and non-bank financial institutions is to some extent artificial, however, the banking financial institutions are authorized by the Central Bank of Brazil to accept deposits and this makes the distinction. Demand deposits, for example, are registered bonds that generate a current account deposits which can be withdrawn at any time by check. In principle, deposits generate bonds that can be traded in financial markets, but in the same way that banking institutions operating in the credit market, credit societies, financing and investment, which are not banks, have done so.

On the other hand, investment banks do not act in the credit market, but on the capital market. Currently, however, multiple banks diversified their activities as service providers. Thus, as regards financial services, there are a variety of them, such as banking, trust services, brokerage services and custody services (custody).

4.1. Sectoral analysis of the direct and indirect effects on the economy of the Brazilian Amazon

Direct technical coefficients of the matrix represent both the value of inputs as the value added (products) required for a given economic activity to produce the equivalent of a unit of gross value of production (or GVP). These technical coefficients of inter-sectoral matrix *A* capture the amount of inputs required to produce a quantity of products of a given industrial activity of the regional economy.

In 1999, the direct effects derived from the matrix of inter-sector flows, showed that for every R$ 1,000.00 of gross value of production generated by financial institutions in the Brazilian Amazon economy. Of this amount, are: the expenditure of about R$ 76.80 to purchase services within the financial sector itself; R$ 150.90 to purchase services sector “other services”; R$ 16.50 of the telecommunication sector; R$ 11.50 in the transportation sector; R$ 4.70 in the cellulose industry, paper and graphic; R$ 7.50 in the “other industries; R$ 1.90 trade sector; R$ 4.0 in the energy sector; R$ 1.10 in the education sector, as can be seen in Table 2.

TABLE 2

AVERAGE PROPENSITY TO SPEND MATRIX OF MCS IN THE BRAZILIAN AMAZON: 1999

Number of Sector	Production Description/Sector Description	Average propensity to spend matrix of Social Accounting Matrix	
		Effect Sale	Effect Purchase
1	Agriculture	0.0055	0.0000
2	Livestock	0.0051	0.0000
3	Forest	0.0049	0.0000
4	Mineral extraction	0.0283	0.0000
5	Non-metallic mineral	0.0134	0.0000
6	Metallic mineral	0.0101	0.0000
7	Machines, Equipments and automobiles	0.0071	0.0000
8	Wood and furniture	0.0035	0.0000
9	Cellulose, paper and graphic	0.0091	0.0047
10	Textile, clothing and leather	0.0068	0.0000
11	Vegetal Agribusiness	0.0087	0.0000
12	Animal agribusiness	0.0074	0.0000
13	Other industries	0.0073	0.0075
14	Energy	0.0178	0.0040
15	Health and sanitation	0.0047	0.0013
16	Construction	0.0033	0.0000
17	Trade	0.0213	0.0019
18	Transport	0.0163	0.0115
19	Telecommunication	0.0169	0.0165
20	**Financial Institution**	**0.0768**	**0.0768**
21	Education	0.0003	0.0011
22	Storage	0.0003	0.0055
23	Other services	0.0060	0.1509

Source: Made by the authors.

4.2. Sectoral analysis of the transfer effects for the economy of the Brazilian Amazon

The Social Accounting Matrix is important for structural analysis because makes endogenous social institutions and added value appropriated by them, but to measure the effects of exogenous variables on endogenous variables is necessary to partition the *A* matrix in order to specify at least one of the accounts as exogenous, as previously shown. In the case of the Amazon economy, the exogenous accounts include flows from the exports of the region with the rest of the world and of Brazil, as well as the flow of net subsidies taxes.

The Social Accounting Matrix is important for structural analysis because endogenize social institutions and the value added by them appropriate. Because of this, the analytical power of Social Accounting Matrix is broader –as it involves all economic transactions in the market for goods and services and factor markets– than the Matrix Input-Output. However, to measure the effects of the exogenous variables on the endogenous variables you need to partition the matrix to specify at least one of the accounts as exogenous.

Thus, in a partitioned array have been some columns representing endogenous activities and representing some other exogenous accounts. In the case of the Brazilian Amazon economy, exogenous accounts include flows of exports from the region to the rest of the world and Brazil, as well as taxes less subsidies flows. Starting from ma solving methodology adopted by Santana (2004), the lines of exogenous accounts of the matrix are excluded from the partitioned matrix and the columns of the exogenous accounts form the vector X_k impacts ($k = a, i, v$).

The array of effects-transfer Stone, which derives from the partitioned Social Accounting Matrix, is important to sector analysis because it captures the multiplier effects resulting from transfers of input-output relationships between and among the array of productive activities. Taking Table 3 as an analytical reference in the annex, it is noted that the financial institutions of the Brazilian Amazon economy impacted other regional economic activities and were also impacted by them. Indeed, we note that for the regional financial sector could meet an incremental stimulation of exogenous demand of R$ 1,000.00 in 1999, financial institutions need to purchase inputs (financial services) within the financial sector itself in the amount of R$ 85.60 as reinforces the same Table 3.

TABLE 3

TRANSFER-EFFECTS MATRIX OF STONE FOR THE BRAZILIAN AMAZON: 1999

Number of Sector	Production Description/Sector Description	Transfer-Effects Matrix of Stone	
		Effect Sale	Effect Purchase
1	Agriculture	0.0087	0.0012
2	Livestock	0.0082	0.0003
3	Forest	0.0062	0.0002
4	Mineral extraction	0.0354	0.0001
5	Non-metallic mineral	0.0193	0.0003
6	Metallic mineral	0.0175	0.0004
7	Machines, Equipments and automobiles	0.1010	0.0018
8	Wood and furniture	0.0080	0.0001
9	Cellulose, paper and graphic	0.0151	0.0074
10	Textile, clothing and leather	0.0130	0.0002
11	Vegetal Agribusiness	0.0166	0.0005
12	Animal agribusiness	0.0138	0.0005
13	Other industries	0.0112	0.0133
14	Energy	0.0294	0.0097
15	Health and sanitation	0.0098	0.0023
16	Construction	0.0066	0.0023
17	Trade	0.0266	0.0063
18	Transport	0.0212	0.0159
19	Telecommunication	0.0200	0.0204
20	**Financial Institution**	**0.0856**	**0.0856**
21	Education	0.0010	0.0014
22	Storage	0.0050	0.0073
23	Other services	0.0083	0.1761

Source: Made by the authors.

Another way to analyze the transfer-effects of the financial institutions on the other activities in the region is through the sectoral multiplier effects. Financial Institutions of the Brazilian Amazon, in terms of input purchases from other sectors in 1999, responded to an external demand variation of R$ 1 billion acquiring inputs of construction sector suppliers in the amount of R$ 2.3; R$ 6.3 trade sector; R$ 7.3 million of the storage industry; R$ 9.7 million in the electricity sector; R$ 15.9 million in the transport sector; R$ 20.4 million in the telecommunications industry; R$ 176.1 million in the sector "other services" as shown in Table 3.

This only confirms inter-sectoral connection of the Brazilian Amazon economy and the existence of relations financial that should be taken into account by sector policymakers adjusted to local clusters.

4.3. Sectoral analysis of the circular effects on the economy of the Brazilian Amazon

The results of matrix-round effects on the economy of the Brazilian Amazon are shown in Table 4. Note that these results reveal the circular flow of said matrix, i.e., this matrix shows the effects departing from productive activities and flow to the value added and leave this to the institutions in the form of income that ultimately is spent on the purchase of goods and services produced by productive activities, thus closing the cycle.

It is through the circular-effect that the initial injection of an exogenous variable is spread throughout the economy and the result is manifested at a more advanced development stage of a regional economy. The results listed in Table 4 of the circular-effects matrix shows the impact of inter-sectoral multipliers that are derived from certain economic transactions that the Input-Output Matrix fails to get.

This advantage of the circular-effects matrix results from the fact that the part of the gross production value, which exceeds the purchase of inputs for a given activity, is converted into income and is spent, via circular effect, during acquisition of new consumer goods and new capital goods from productive activities. The same interpretation pattern can be applied to Financial Institutions.

Indeed, for a R$ 1 billion increase in exogenous demand in 1999 led to the financial institutions of the Brazilian Amazon economy had spent on purchase of inputs - financial services in general, including deposit-taking in 1999, a total of approximately R$ 84.5 million in the sector of agriculture; R$ 126.2 million in the livestock sector; R$ 93.7 million in the agribusiness sector of the plant; R$ 123.7 million in the agribusiness sector animals; R$ 236.1 million in the sector "other industries"; R$ 146.7 in the electricity sector; and R$ 121.2 million within the financial sector itself, as confirmed by Table 4.

That same year, by contrast, the financial institutions of the Brazilian Amazon sold their financial products and services to all sectors with whom they negotiate. Among these sectors should be highlighted: Agriculture (R$ 74.2 million); Livestock (R$ 69.7 million); Forest (R$ 88.1 million); Non-metallic minerals (R$ 90.9 million); Metallic minerals (R$ 69.4 million) and education (R$ 134.3 million), as confirmed by Table 4.

TABLE 4

CIRCULAR-EFFECTS MATRIZ OF STONE FOR THE BRAZILIAN AMAZON: 1999

Number of Sector	Production Description/Sector Description	Circular-Effects Matrix of Stone	
		Effect Sale	Effect Purchase
1	Agriculture	0.0742	0.0845
2	Livestock	0.0697	0.1262
3	Forest	0.0881	0.0026
4	Mineral extraction	0.0821	0.0036
5	Non-metallic mineral	0.0909	0.0264
6	Metallic mineral	0.0694	0.0213
7	Machines, Equipments and automobiles	0.0646	0.0754
8	Wood and furniture	0.0881	0.0171
9	Cellulose, paper and graphic	0.0810	0.0303
10	Textile, clothing and leather	0.0690	0.0106
11	Vegetal Agribusiness	0.0764	0.0937
12	Animal agribusiness	0.0722	0.1237
13	Other industries	0.0678	0.2361
14	Energy	0.0924	0.1467
15	Health and sanitation	0.1039	0.2380
16	Construction	0.0850	0.4148
17	Trade	0.0859	0.2557
18	Transport	0.0797	0.1755
19	Telecommunication	0.1041	0.1171
20	**Financial Institution**	**0.1212**	**0.1212**
21	Education	0.1343	0.3121
22	Storage	0.0882	0.1330
23	Other services	0.1137	1.6009

Source: Made by the authors.

Through the obtained results, it was found that the resulting cross-sector multiplier effect circular-are more robust than the multiplier effects of the transfer for the reasons stated.

4.4. Sectoral analysis of the overall effects for the economy of the Brazilian Amazon

Output is necessary to recall that the purpose-global matrix comprises the sum of the effects of the transfer matrices, cross and circular analyzed. The array of global-effects shows all direct and indirect impacts of some variation of exogenous demand.

The matrix of the overall effects derived from the Social Accounting Matrix, is completely conditioned by exogenous demand, as in Keynesian models, since there

is no restriction of supply that is taken for granted. In fact, in each experimental situation in order to analyze the impact of exogenous variables on the endogenous variables, the shock always comes from external demand. The multipliers-global matrix effects are therefore are sensitive to the choice of vector exogenous demand, in the same way as the realism of the model results depends on the question chosen for analysis. A certain length of this line can be developed through the structural analysis steps multipliers.

The Table 5 shows the global impacts caused by unit changes in exogenous demand for goods and services sectors of the economy of the Brazilian Amazon resulting from cross-sector economic interactions (shown on the main diagonal), with the network providers that reveals the effects back (presented in columns) and also with the customer network that reveals the effects forward (presented in lines).

To start analysis, becomes only the column 20 of the array of global multipliers of the economy of the Brazilian Amazon, year 1999 corresponding financial institutions or Financial Sector, as can be seen in Table 5. In this column, it is clear that an increase to one billion reais in exogenous demand for financial products and services in the financial sector, caused an additional increase of approximately R$ 206.80 million in the financial sector itself which, added to a 1 million actual initial injection totaling R$ 1,206.8 million. The results analyzed column 20 of Table 5 indicate that the financial industry located in northern Brazil has a reasonable amount to boost capacity in the case of a provider of financing activity and loans for other activities.

Table 5 plus the coefficients of intra-sectoral multipliers, other important inter-sectoral increases in demand for inputs from the regional financial sector spread up to other economic activities, as a result of initial injection of one billion reais, such as: R$ 85.7 million for agriculture; R$ 126.5 million for livestock; R$ 156.3 million at the electricity sector; R$ 417.1 million for construction and R$ 1,777.1 million for the sector “other services”, as shown in column 20 of Table 5.

These values reflect the expansion required for each economic sector to meet the demand of unit increments. It follows, therefore, that the incentives caused by increased exogenous demand not induce despite variations of the magnitudes of the coefficients of inter-sectoral links, only the growth of individual activities, but also of the Brazilian Amazon economy as a whole.

It is also important to observe the impacts caused by global multipliers on institutions and on the income distribution of the Brazilian Amazon economy sectors, in particular of Financial Institutions. Indeed, the exogenous demand increase in R$ 1.0 billion spread direct and indirect multiplier effects on the institutions (families, enterprises and government). For the financial sector case, the increase demand for consumer goods in 2000 was of R$ 2,010.0 million, which, added to the initial injection of R$ 1,000.0 million, increased global demand for consumer goods of the Brazilian Amazon economy in R$ 3,010.0 million.

TABLE 5

MATRIX GLOBAL-EFFECTS OF THE BRAZILIAN AMAZON: 1999

Number of Sector	Production Description/Sector Description	Matrix Global-effects of the Brazilian Amazon	
		Effect Sale	Effect Purchase
1	Agriculture	0.0828	0.0857
2	Livestock	0.0779	0.1265
3	Forest	0.0943	0.0028
4	Mineral extraction	0.1175	0.0036
5	Non-metallic mineral	0.1101	0.0267
6	Metallic mineral	0.0870	0.0217
7	Machines, Equipments and automobiles	0.0747	0.0772
8	Wood and furniture	0.0961	0.0172
9	Cellulose, paper and graphic	0.0961	0.0377
10	Textile, clothing and leather	0.0820	0.0109
11	Vegetal Agribusiness	0.0930	0.0942
12	Animal agribusiness	0.0860	0.1242
13	Other industries	0.0790	0.2494
14	Energy	0.1218	0.1563
15	Health and sanitation	0.1137	0.2403
16	Construction	0.0916	0.4171
17	Trade	0.1125	0.2620
18	Transport	0.1009	0.1915
19	Telecommunication	0.1241	0.1375
20	**Financial Institution**	**1.2068**	**1.2068**
21	Education	0.1352	0.3135
22	Storage	0.0932	0.1403
23	Other services	0.1220	1.7771
24	Families	0.1433	3.0100
25	Brutal Fixed Capital Formation	0.0584	0.6903
26	Wage	0.1433	2.0374
27	Profit	0.1010	1.3850

Source: Made by the authors.

In addition, corporate institutions and government were also negatively impacted as the same magnitude of the initial injection led to an increase in brutal fixed capital formation of only R$ 690.3 million, as shown in column 20 of Table 5. The effects of the global multipliers have spread also on the level and income distribution of the Brazilian Amazon.

These economic impacts were captured by increase in the level and distribution of added value –expressed in the form of wages and profits– generated by financial institutions located in the northern region of Brazil. Indeed, it is noted that in 1999, the value added of the financial sector increased as a result of the initial injection of one billion reais, for a total of R$ 3,422.4 million. This value, about 59.53% were appropriated by the working class in the form of wages; and 40.70% for the business class in the form of profits, as can be seen in column 20 of Table 5.

Another way of interpreting the global multiplier effects derived from the Social Accounting Matrix of the Brazilian Amazon economy in 1999 can be made from the response issued by a given activity elected to the stimulus caused by a unitary and simultaneous injection to other productive activities downstream.

In this case, the reading of the overall multiplier-global matrix effects is performed along the lines of Table 5, where in 1999, a unique injection of a billion reais caused by exogenous demand has resulted in an overall multiplier effect on the financial institutions in terms of sales of financial products and services, ranging from a minimum of R$ 74.7 million of the production machinery industry, equipment and vehicles, to a maximum of approximately R$ 1,206.8 million within the financial sector itself as indicated in line 20 of Table 5.

These results indicate that the financial industry responded in 1999 to demand more strongly impacts within the activity. This only reinforces the immediate need for a national regional financial sector development policy in order to add more value to products and services in the financial sector of the Amazonian economy in order to strengthen further the relations of interdependence between the financial sector and other productive sectors the Amazon region.

This variability of global multiplier effects is a factor that can limit the improvement of income distribution and employment structure of the regional economy. To mitigate this situation we need to know more deeply the conditions of regional production structure to prevent, by agents, certain decisions that penalize the poorest economic sectors and/or block those channels that can facilitate sustained economic growth of the Amazon economy Brazilian.

In short, this variability implies that the overall multiplier effects in the economy of north of Brazil depend on the regional demand structure; and that the expenditures of economic agents in the procurement of goods and consumption and investment services differ from company to company and consumer to consumer. The robustness of intra and inter-sectoral relations generated within and between the financial sector and other activities of the industry supply chain, especially those closest Financial Institutions upstream and downstream, reveals the structural power of a key industry.

Apparently here in 1999, the Financial Institutions responded to stimuli of all activities of its chain with emphasis on the sectors of the mining industry, agriculture, civil construction, “other services” and “other industries”. The degree of weak robustness of the overall multiplier of the financial sector, to the majority of the Amazon economy sectors indicates that the regional financial sector does not have a strong power of drag on the growth of other regional productive activities to trigger a process of financing for Development a la Hirschman in the Brazilian Amazon.

4.5. Analysis of the Keynesians multiplier effects

To analyze the real ability of the sectors generating product Amazon economy, employment and income sector, it will make use of the multipliers of product concepts, employment and income (wages and profits). These multipliers capture the product of generation capacity, employment and income, directly and indirectly, through the exogenous unit increase in demand and also were calculated from the array of global

multiplier effects (M_g) and their vectors-column and row vectors of the variables considered: product, employment and income.

4.5.1. *The product multiplier*

The product multiplier (MP_j) is derived from the equation:

$$MP_j = \sum_{i=1}^{n} A_{ij}$$

Where A_{ij} are the coefficients of direct and indirect effects of the M_g column-vectors, which measures the variation of the total output of all productive sectors of the Amazon economy in response to variations of a monetary unit of final demand for products of a specific sector considered for analysis.

In the case of financial institutions, the multiplier of 5.7202 order product suggests that in 1999, an increase to R$ 1 billion of final demand, financial institutions responded with an increase of approximately R$ 5,7202 million inputs (financial products and services) to meet this increase in final demand, as can be seen in Table 6 in the next section.

The financial sector multiplier product is one of the strongest among the sectors of the Amazon economy, including standing up average product of the multiplier (4.5556) of the regional economy, as confirmed by Table 6.

4.5.2. *The employment multiplier*

The sectoral employment multiplier (ME_j) is derived from the formula:

$$ME_j = \frac{E_j}{e_j}$$

Where: $E_{j(1x23)} = e_{j(1x23)}.M_{g(23x23)}$

It means that E_j represents the direct and indirect employment coefficients calculated by the previous multiplication of the vector-line of direct employment (ej) by the direct and indirect coefficients of the global effects matrix (M_g). Therefore, the employment multiplier measures the capacity of employment generation in each sector in response to exogenous variation of a monetary unit of the final demand.

In the case of financial institutions, the employment multiplier is 19.8506 of order, so one of the strongest of the Brazilian Amazon economy. This means that for an exogenous increase of R$ 1 billion of final demand, the financial sector of the economy of the region responded with a generation of direct and indirect jobs in 1999, around 19.851, so well above the regional average, as confirms Table 6 in the next section.

These indicators confirm the strategic importance of regional financial sector to leverage the development of the Amazon in Brazil.

TABLE 6

KEYNESIAN MULTIPLIERS OF OUTPUT, EMPLOYMENT AND INCOME IN THE ECONOMY OF THE BRAZILIAN AMAZON: 1999

Sector	Multipliers			Linkages Effects	
	Product	Employment	Income	Backward Linkage Effects	Forward Linkage Effects
Agriculture	4.0305	2.3178	0.9933	1.459	0.4119
Livestock	3.9060	3.7468	0.5721	1.6678	0.4283
Forest	4.4527	1.9725	1.4174	0.7983	0.1848
Mineral extraction	4.3905	13.728	0.1756	1.2576	0.1888
Non-metallic mineral	4.7275	6.8895	0.3865	0.8131	0.7068
Metallic mineral	4.1051	11.5438	0.1702	1.5633	0.3886
Machines, Equipments and automobiles	3.5814	18.4242	0.0986	2.272	0.4133
Wood and furniture	4.6566	3.7873	0.6716	0.9692	0.3245
Cellulose, paper and graphic	4.4048	8.6879	0.2609	1.3692	0.8384
Textile, clothing and leather	4.0827	2.6446	0.7237	1.6238	0.7733
Vegetal Agribusiness	4.5709	10.4126	0.2122	0.9789	0.9007
Animal agribusiness	4.3539	22.3871	0.0938	1.1313	0.8017
Other industries	3.8013	11.368	0.1715	1.9482	1.0159
Power	4.9530	37.9791	0.0661	0.9857	1.2722
Health and sanitation	5.1396	5.5305	0.5223	0.8054	1.3188
Construction	4.4538	6.4125	0.3947	1.0455	1.2188
Trade	4.4684	3.6033	0.6758	1.4263	0.6912
Transport	4.1958	3.5998	0.6351	1.5918	0.9604
Telecommunication	5.0399	38.8094	0.0785	0.4979	2.1422
Financial Institutions	**5.7202**	**19.8506**	**0.1724**	**0.15**	**1.6117**
Education	5.8254	2.841	1.3175	0.1355	1.6554
Storage	4.6347	1.996	1.2484	1.0301	1.711
Other services	5.2828	5.6529	0.5738	0.487	1.7526
Region's average	**4.5556**	**10.6168**	**0.5057**	**1.1307**	**0.944**

Source: Made by the authors.

4.5.3. *The income multiplier*

The sectoral aggregate income multiplier (MR_j) is derived from the equation:

$$MR_j = \frac{R_j}{r_j}, \text{ Wherein: } R_{j(1x23)} = r_{j(1x23)} M_{g(23x23)}$$

This means that the calculation of the income multiplier (MR_j) is obtained by dividing the values of the vector-line of income (salaries plus profits) direct and indirect effects of the global-effects matrix (R_j) by the values of the vector-line income direct coefficients (r_j).

In the case of the financial sector of the economy of the Brazilian Amazon, there is the multiplier of the aggregate income is relatively low, even falling below the regional average when compared with other sectors with greater power of generating income. Indeed, for an increase of R$ 1 billion in final demand, the financial sector in the region responded with an increase of only R$ 172.4 million in income, as shown in Table 6.

4.6. Analysis of the linkages backward and forward effects

In this section, we discuss the economic impacts of interconnections between various activities of the Social Accounting Matrix 1999 of the Brazilian Amazon economy. In the face of inter-regional income inequalities, one of the goals of regional economies of the Brazilian periphery is to obtain a quick income growth.

To do this, industrialization and regional agro-industrialization may help reduce the economic gap between the rich and poor regions. In this context, it is very important to choose the regional economic development strategy due to lack of resources to operate a volume of broad and diversified investment. In this regard, it should be considered the border of the debate on the most appropriate criteria for choosing the productive activities of greater capabilities to leverage regional economic growth.

In this respect, it is important to know the intensity of linkage effects back and forth of productive activities in the Amazon, as one of those criteria for the choice of the most power of leverage key industries. The theoretical framework that guides decision-making of economic agents about the choice of the most appropriate strategy pro-economic development, balanced growth versus unbalanced growth is already well known. Indeed, the concepts of linkages effects backward (retrospective) and forward (prospective) were developed by Hirschman (1961).

Nevertheless, the necessary technique to measure the induced direct and indirect effects on the regional economy was developed by Rasmussen (1963). The inverse Matrix of Social Accounting, *M* is the reference matrix for measuring inter-sectoral linkages. The choice of this alternative due to the fact that the Social Accounting Matrix incorporate, besides the intermediate demands (inputs), final demands by consumer spending and investment, and the income of the factors of production and its distribution between the institutions.

Therefore, the coefficients of the linkages derived from the Social Accounting Matrix are more robust than the input-product matrix, as they capture all direct and indirect effects of exogenous changes in final demand for all sectors of the regional economy.

4.6.1. *Determining method of the chaining effects coefficients*

The identification of key-industries in a regional economy is made through the analysis of the backward (U_j) and forward U_i linkage effects coefficients from the Social Accounting Matrix for the year 1999 of the Brazilian Amazon economy.

These effects are defined as follows:

1) $U_j = [(M_{aj} / n) / \overline{M_a}]$

Wherein U_j measures the backward linkage effect;

M_{aj} is the coefficients sum of a given column *j* of the inverse Social Accounting Matrix of *M*;

$\overline{M}_a$ is the average of all *Ma* matrix elements.

2) $U_i = [(P_{ai} / n) / \overline{P_{ai}}]$

wherein U_i measures the forward linkage effect,

P_{ai} = is the sum of the coefficient of a determinate line *i* of inverse Social Accounting Matrix;

$\overline{P_a}$ = is the average of all elements of the P_a;

n = is the number of productive activities of the reverse Social Accounting Matrix.

Since the average (M_{aj}/n) show the intermediate inputs purposes, if the final demand *j* productive activity increment of a unit, then $U_j > 1$ indicates that productive activity to that already relies heavily on inputs produced in other productive activities, and vice versa where $U_j < 1$. This coefficient that captures the backward chaining effect was developed by Rasmussen (1957) and accepted by Hirschman (1961) found that as a good indicator to identify key industries for developing economies.

As for the coefficient that captures the forward chaining effect, this was developed by Jones (1976) which uses an array *m* product coefficient *P* in place of the technical coefficients used in the model Rasmussen (1957). According to Santana (2004), to facilitate the interpretation of the ranking of the key sectors of the economy of the Brazilian Amazon, both coefficients back and forth were normalized by the global industry average

The Activities or industries that have high linkage effects backwards ($U_j > 1$) and forward ($U_i > 1$) are those who should have greater power to induction of the product of a given regional economy through the external economies generated by demand or supply-side economics.

4.6.2. *The method of determination of the coefficients of linkage effects*

Taking the Table 7 as a reference, it is clear that in 1999, there were three productive activities with linkages effects backwards and forwards greater than unity. That same year, the financial institutions located in the Brazilian Amazon presented an index of the bonding effect backwards ($U_j = 0.1500 < 1$) lower the unit. Therefore, financial institutions in the Brazilian Amazon economy have low connection power back to the productive activities situated upstream of its position, as shown in Table 7.

Still to Table 7, it is noted that the financial institutions of the region have an index of the bonding effect forward ($U_i = 1.6117 > 1$) greater than unity. This means that the financial sector in the region is connecting more with the activities downstream of its position in the economic structure of the region. Thus, it is strengthening over the final demand for its financial products and services by productive activities and social institutions.

TABLE 7

BACKWARD LINKAGE EFFECTS AND FORWARD LINKAGE EFFECTS OF ECONOMIC SECTORS, ESPECIALLY OF FINANCIAL INSTITUTIONS OF THE BRAZILIAN AMAZON: 1999

Sector	Linkages Effects	
	Backward Linkage Effects	Forward Linkage Effects
Agriculture	1.459	0.4119
Livestock	1.6678	0.4283
Forest	0.7983	0.1848
Mineral extraction	1.2576	0.1888
Non-metallic mineral	0.8131	0.7068
Metallic mineral	1.5633	0.3886
Machines, Equipments and automobiles	2.272	0.4133
Wood and furniture	0.9692	0.3245
Cellulose, paper and graphic	1.3692	0.8384
Textile, clothing and leather	1.6238	0.7733
Vegetal Agribusiness	0.9789	0.9007
Animal agribusiness	1.1313	0.8017
Other industries	1.9482	1.0159
Power	0.9857	1.2722
Health and sanitation	0.8054	1.3188
Construction	1.0455	1.2188
Trade	1.4263	0.6912
Transport	1.5918	0.9604
Telecommunication	0.4979	2.1422
Financial Institutions	0.15	1.6117
Education	0.1355	1.6554
Storage	1.0301	1.711
Other services	0.487	1.7526
Region's average	1.1307	0.944

Source: Made by the authors.

Consequently, the Financial Institutions in the Amazon economy have low backward linkage power to productive activities located upstream of its position. By the same table, note that the Financial Institutions of the region have an index of the forward linkage effect ($U_i = 1.6117 > 1$) greater than unity.

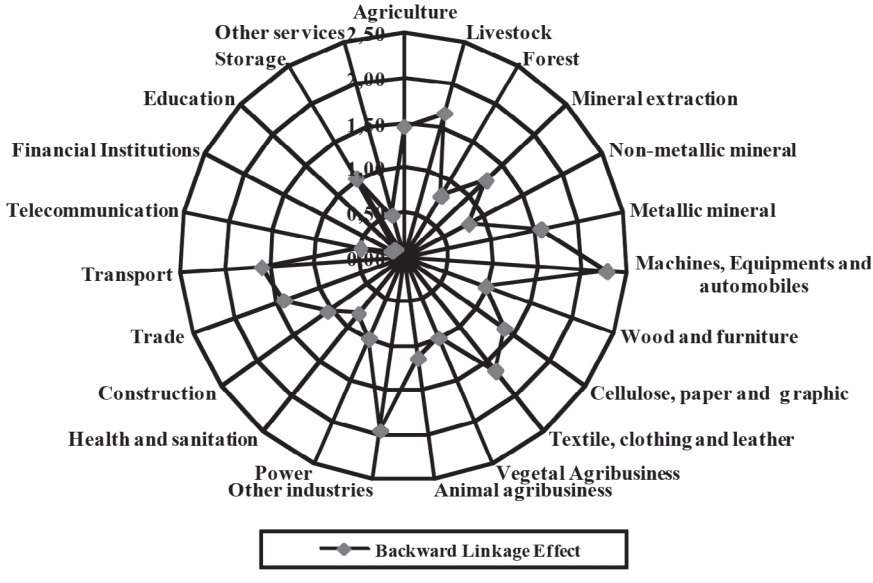
This means that the region's financial sector is connecting more and more with the activities of the downstream position in the economic structure of the region, it means, it is strengthening final demand for their products and financial services by the productive activities and social institutions part.

Because of this the behavior of indices that capture the links of effects back and forth of productive activities in the Brazilian Amazon, despite the stabilization policy of the federal government and discretionary economic growth policy by forced marches that penalizes some productive activities to the detriment other, most sectors of the regional economy had expanded their structural economic relations, as shown in Graph 1 and Graph 2.

The fragility of the backward linkages effects in the financial sector may have some validity under certain historical conditions exclusionary regional development that is just waiting for the exclusive logic of the market performance. However, in a

GRAPH 1

BACKWARD LINKAGES EFFECTS OF SOCIAL ACCOUNTING MATRIX OF THE BRAZILIAN AMAZON: 1999



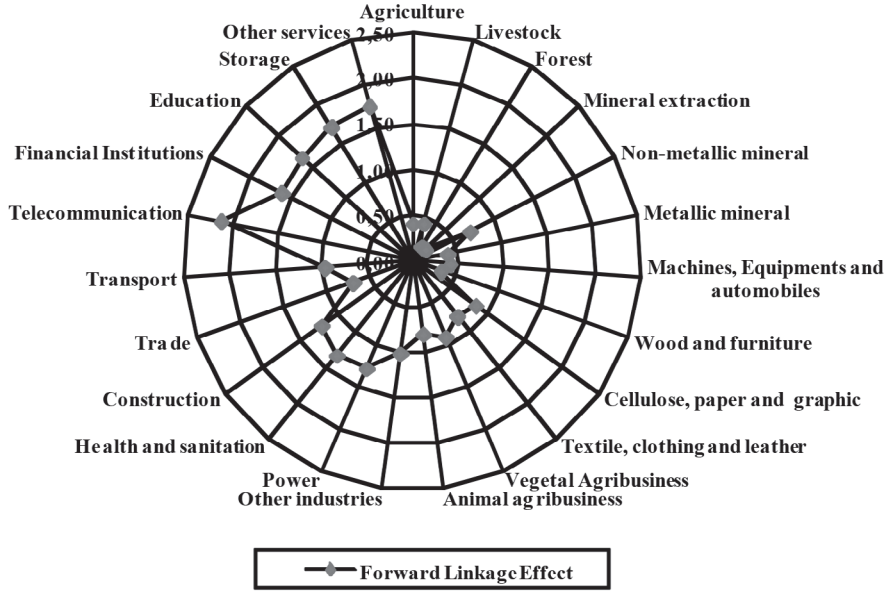
Source: Made by the authors.

regional economy where the state is present with investments in basic social capital, allocation of tax credit and incentives, besides the purchasing power of state enterprises, the combined effects of these pro-development tools can overcome this inertia and enable strategic private investment generator of scale economies, scope economies and external economies by increasing the industrial plant, the product differentiation and the deepening of vertical integration - through the market' support, especially in the current globalization context.

The level of structural interdependence among the productive activities of the region's economy, can be derived both from the inputs offer from other activities to the considered productive activity –causing the backward effects– as from demand for products of this considered activity, by other activities, allowing the emergence of forwards effects. Moreover, regional economic development can be stimulated by the forces of final demand connections, according to the Keynesian tradition, associated with the income structure (added value) which, in turn, binds to the regional productive structure, through social institutions, closing the circular flow specified by the Social Accounting Matrix of the Brazilian Amazon 1999.

GRAPH 2

FORWARD LINKAGES EFFECTS OF SOCIAL ACCOUNTING MATRIX OF THE BRAZILIAN AMAZON: 1999



Source: Made by the authors.

5. CONCLUSION

This work can be seen that the current trend of bank concentration in big cities limits the financing of investments in the regions of the national periphery, and therefore the economic development of the Brazilian Amazon. The process of financial concentration in the center also helps to expand the industrial concentration in the Southeast given the conventional base of credit to the activities of the periphery.

Therefore, the analysis highlights the need for government intervention to prevent the continuation of this perverse process concentrator of wealth and income in Brazil. The financial dimension of regional issue, particularly in northern Brazil, deserves to enter the government agenda among other reasons by the constitutional need for the federal pact seek national integration, not least because the own Ministry of National Integration was established for that.

In addition to the strong banking and financial flows in the center-center and center-periphery is need to strengthen the fragile banking and financial flow in the center-periphery direction through an integrated economic policy that reconciles systemically macroeconomic policies –monetary, fiscal and foreign exchange– with sectoral policies (industrial, agricultural, commercial and technological innovations) and regional policies for sustainable development.

But, it is necessary that the integrated actions of these economic policies are coordinated by planning agencies of the regions of the periphery. In turn, domestic banks and regional, public and private, should be subject to appropriate regulations to which may play an important role in contributing to regional development in order to reduce the gap between the center and the periphery as predict the article 192 Constitution of the Federative Republic of Brazil.

In the economy of the Amazon, productive activities establish a network transactions and economic relations of intra and inter-sectoral nature. In the case of financial activities that operate in the Brazilian Amazon the rule is the same, so the quantitative understanding of the economic importance of these economic relations can become a powerful planning tool to guide decisions of private agents and the federal government itself with regard to the implementing economic policies geared to the development of the regional economy.

In this work, the main objective was to measure and interpret the effects caused by the financial institutions on the other sectors of the Brazilian Amazon economy in terms of economic impacts raised by the transfer matrices, cross, circular and global, when subjected to an exogenous unit change of final demand. There was also the need to seek the quantification and analysis of the effects caused by these financial institutions on other productive activities of the Amazonian economy, in terms of product creation, income generation and employment.

In addition, we attempted to analyze, for identification of the Amazon key industries, the linkage effects back and forth caused by financial institutions upstream and downstream of the production chain of financial services. To meet these goals, there was use of Social Accounting Matrix of the Brazilian Amazon economy of 1999. We adopted the matrix modeling technique to calculate the appropriate economic indicators from the Social Accounting Matrix.

Through these economic indicators, it was then possible to measure trade flows of productive activities and views the conditioning factors that influence the sectoral fluctuations in the Amazon economy. An analysis by the demand side provides information on the various economic agents of the Brazilian Amazon interact –families, businesses, government and the rest of the world– to you and to each other so as to constitute an aggregate market demand for financial firms and non-financial meet. An analysis on the supply side of goods and services requires that the activities are able to employ the factors of production, capital and labor in sufficient quality and quantity to produce the goods that have demand in the market.

In the Brazilian Amazon, the shortage of available supply of skilled labor and additions and renovations to gross capital stock, via investment, limit the amount of production that may be destined for the end market. Meanwhile, the economic connection between supply and demand markets, are the various intermediate transactions that define the technological standard of the regional economy. Understanding these limits to the Brazilian Amazon's economic growth is of paramount importance, since exogenous variations of final demand directly and indirectly affect the sectors of the economy and the efficient allocation of resources.

In general, financial institutions that operate in the Brazilian Amazon economy is integrated with other productive activities that end up playing a range of significant results necessary for the preparation of viable planning strategies for the Amazon development. This work can be seen that the Social Accounting Matrix Amazon in 1999 can be used to support the development theory of Hirschman. To this end, the Amazon economy is theoretically designed based on the concepts of gross production value, value added and income distribution; all these concepts articulated the operating dynamics of the circular flow and sectoral productive chains.

The Model Social Accounting Matrix provides a structural view of the economy of northern Brazil to allow optimization, via multiplier effects and linkage effects back and forth, the development of interconnected sectors. This alternative model the Input-Output Matrix also facilitates the understanding of the impacts of macroeconomic policies, sectoral policies and by the regional policies in the regional economy as a whole.

In the case of the financial sector, the linkage effects are weak back and forward linkage effects are robust enough to trigger effective sequences to other chains, especially in the application and obtaining loans. Still, it can be said that the financial industry in the Brazilian Amazon, by submitting their knock-on effects backward ($U_t < 1$) and forward ($U_f > 1$) incomplete still do not constitute a key industry in the sense of author, Hirschman.

The matrix of global multipliers derived from the Social Accounting Matrix, was broken down into three partitioned matrices: the matrix-transfer effect that captures the technical input-output relations; the matrix-cross effect, which captures the impacts transmitted between blocks of different activities; and end-circular array, that captures the distribution of the results within the economy.

In this regard, it can be said that Amazon's productive structure in 1999, especially regarding the studied sector, it is still a reflection of the low level of inter-sectoral concatenations able to allow the functioning of the economy in other bases. In addition, the inefficient conduct of regional policy of financial incentives and

credit of the government banks, financing individual projects without intra and inter concatenations, instead of funding clusters and structural clusters of supply chains in the Amazon region, certainly over causing an underperforming the GDP growth per capita in the Brazilian Amazon in recent years. This is made evident when we compare the economic impacts of the global multipliers and inter-sectoral links the various production activities in the region.

Regional policy of tax incentives in the Brazilian Amazon acted selectively and partially on the basis of purely political criteria and not by clear rules based on technical and economic criteria. Therefore, this policy did not attract the driving industries promoters of the effects of attraction to the formation of industrial and agricultural complexes that could sustain a wave of further industrialization able not only to promote economic growth, as disseminate it to all economic agents in the form of distribution of income and employment. In fact, the national regional development policy was distorted to the extent that only favored primary production and human occupation without regard to the need for the formation of generating productive chains of external economies.

The impact of the multiplier effect of public investment, particularly in energy, although important not unleashed centrifugal forces of attraction for activities that generate sequential pulses able to radiate economic growth around the production chains in industrial areas as recommended by the Development Plans Brazilian Amazon. The decomposition of the matrix of global multiplier effects in the economy of the region, transfer effects, cross and circular, reveals a distributive structure of the income and own regional employment a primary export economy based on the transfer effect also plays an important role. Through the analysis of indicators of the Social Accounting Matrix, is visible from the integration point of view, that process of horizontal integration of the productive sector (intra-sectoral) in the Brazilian Amazon has advanced, however, and productive vertical integration (inter-sectoral) is still insufficient.

Despite the improvement in the trade balance of the Brazilian Amazon with the rest of the world over the last twenty years, yet the terms of trade are unfavorable to the region. This translates, in a way, maintaining economic dependence of the region since the law of deteriorating trade prevents this situation is broken, via adoption of more efficient technologies, as this mechanism has just draining of the income generated internally in region to the rest of Brazil and the world.

To break this technological and economic dependence it is necessary to set, and a national policy for development of technological innovations at the regional level, a new national regional development policy that favors the formation of integrated supply chains and a trade policy that stimulates one agenda of broad and diversified export products with high added value so that the benefits arising there can be internalized in the form of income and employment by economic agents in the Amazon region.

It should be noted that with the Law Kandir the northern economy no longer rely on a fiscal mechanism for compensating the extraction and export of its non-renewable resources. In fact, the mineral export base states were virtually no tax mechanism to finance the attractive economic and social investment companies that have the ability to verticalize production are located in areas where extractive companies.

In the Brazilian Amazon we can see that the degree of structural interdependence between the productive activities of the regional economy can be derived from both the supply of inputs of other activities to productive activity considered, giving the effects back as the product demand this activity considered by other activities, allowing the emergence of the effects forwards.

Moreover, regional economic development may be stimulated by the forces connections involving the final demand, according to tradition Keynes, income associated structure (added value) which, in turn, binds to the regional productive structure via social institutions, closing the circular flow specified by the Social Accounting Matrix 1999. This shows that the financial sector is able to establish strong linkages backwards and forwards with other regional productive activities and should therefore, be one of the key activities of the Brazilian Amazon economy that should be considered important to the sustainable development of the region Northern Brazil.

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EFECTO DIRECTO E INDIRECTO DE LA DISPERSION DE LAS EMISIONES INDUSTRIALES SOBRE LA REGULACION AMBIENTAL

DIRECT AND INDIRECT EFFECT OF THE DISPERSION OF INDUSTRIAL EMISSIONS ON ENVIRONMENTAL REGULATION

GABRIEL RIOSECO VALLEJOS*
Universidad de Concepción

CRISTIAN MARDONES POBLETE**
Universidad de Concepción

JORGE JIMENEZ DEL RIO***
Universidad de Concepción

Abstract

The Concepción Metropolitan Area in Southern Chile has been showing high ambient concentrations of fine particulate matter due to its significant industrial activity. Therefore, this study analyzes various regulatory scenarios in order to help reduce the atmospheric emissions from the industrial activities. Unlike the standard methodology, the source location and the atmospheric conditions were included in the analysis to establish the contribution of these sources to the ambient levels of $PM_{2.5}$ observed in the populated Concepción Metropolitan Area. The results show that if only the direct impact of emissions is considered, the potential reduction in $PM_{2.5}$ concentration is underestimated and the total reduction costs are overestimated. We conclude that if the indirect impacts of the industrial

* Programa de Magíster en Ingeniería Industrial, Universidad de Concepción. Dirección: Edmundo Larenas 215, Concepción, Chile. E-mail: grioseco@udec.cl

** Profesor Asistente. Departamento de Ingeniería Industrial, Universidad de Concepción. Dirección: Edmundo Larenas 215, Concepción, Chile. E-mail: crismardones@udec.cl. Tel.: 56-41-2203614 (autor de correspondencia).

*** Profesor Asistente. Departamento de Ingeniería Industrial, Universidad de Concepción. Dirección: Edmundo Larenas 215, Concepción, Chile. E-mail: jorgejimenez@udec.cl

emissions are not considered in the analysis, there will be an excessive or insufficient regulation on the industrial activities in the air pollution strategies implemented in the Air Pollution management plans of Chile.

Keywords: *Pollution, concentrations,* $PM_{2.5}$.

JEL Classification: *Q50, Q52, Q53.*

Resumen

Concepción Metropolitano en Chile presenta altas concentraciones de material particulado fino, atribuible en parte a su importante actividad industrial. Por lo anterior, se analizan diversos escenarios regulatorios que ayudarían a reducir la contaminación generada por las industrias. A diferencia de la metodología estándar, se estudia cómo la localización de las fuentes emisoras y condiciones de dispersión del contaminante en el aire generan un impacto indirecto relevante sobre las concentraciones de otras comunas aledañas. Los resultados arrojan que cuando se considera solo el impacto directo de las emisiones, se subrepresenta el potencial de reducción en las concentraciones de material particulado fino y se sobreestiman los costos totales de reducción. Así, es posible concluir que existiría exceso o falta de regulación sobre las industrias si no se incorporan en los análisis los impactos indirectos de las emisiones en las medidas evaluadas en los planes de descontaminación aplicados en Chile.

Palabras clave: *Contaminación, concentraciones,* $MP_{2,5}$.

Clasificación JEL: *Q50, Q52, Q53.*

1. INTRODUCCION

Concepción Metropolitano es un área geográfica localizada en la zona centro sur de Chile. Su actividad económica se centra en una fuerte presencia de industrias que se encuentran distribuidas en nueve de las diez comunas que constituyen esta conurbación: Concepción, Coronel, Chiguayante, Hualpén, Lota, Penco, San Pedro de la Paz, Talcahuano y Tomé. La comuna de Hualqui se caracteriza por ser principalmente rural.

Un problema que surge en torno a la actividad industrial está asociado a los contaminantes que se liberan por la quema de combustibles, principalmente material particulado respirable (MP_{10}) y material particulado fino ($MP_{2,5}$). La participación de las emisiones de $MP_{2,5}$ generado por las fuentes industriales de Concepción Metropolitano es de un 22%, el resto del aporte proviene principalmente de la combustión residencial a leña y en menor medida del tránsito vehicular (IIT, 2012).

La principal forma de reducir el $MP_{2,5}$ en las fuentes industriales es mediante la implementación de tecnologías de fin de tubo. Esto se logra con dispositivos que capturan las partículas antes de ser emitidas a la atmósfera, reduciendo considerablemente las emisiones. Para relacionar la reducción de las emisiones en las fuentes industriales con la disminución de las concentraciones en cierta localización o comuna, se utilizan Factores de Emisión-Concentración (FEC). Estos se determinan usando modelos de dispersión y transporte de sustancias en el aire, los que están basados principalmente en ecuaciones matemáticas que simulan el comportamiento de una sustancia en la atmósfera, al incorporar dinámicas de transporte de aerosoles, geografía del lugar, relieves, así como también el patrón de comportamiento de los vientos y los procesos físicos y químicos en el ambiente. Con estos datos de entrada, se determinan los FEC que permiten relacionar las emisiones de $MP_{2,5}$ con los niveles de concentración que se generan en los receptores de interés.

Sin embargo, la gran mayoría de los estudios realizados hasta ahora en Chile para apoyar los planes de descontaminación han evaluado solo el impacto directo de la contaminación, es decir, que las emisiones de las fuentes afectan o aportan con niveles de concentraciones solo en la zona o comuna donde esta se localiza, sin considerar que pueden tener un impacto indirecto de contaminación en otras comunas. De hecho la metodología que propone usar el Ministerio del Medio Ambiente para la elaboración de Análisis General de Impacto Económico y Social (AGIES) en la evaluación de normas y planes ambientales, establece que el cálculo de los FEC se realice considerando que las emisiones de las fuentes generen concentración solo en su propia comuna, sin considerar que puede afectar a otras. Resulta relevante el análisis de levantar este supuesto si se tiene en cuenta que las partículas de $MP_{2,5}$ son muy pequeñas y pueden transportarse cientos de kilómetros antes de ser removidas del aire, por lo que las emisiones pueden afectar muchas zonas o comunas que pudiesen estar muy alejadas de la fuente emisora.

En el caso de la literatura científica que evalúa instrumentos regulatorios en Chile, algunos estudios solo analizan la reducción de emisiones, pero no cómo estas se dispersan en el ambiente (San Martín, 2003; Ponce y Chávez, 2005; Villena *et al.*, 2009; Alegría *et al.*, 2013; Mardones *et al.* 2015), mientras otros trabajos abordan la dispersión de contaminantes en concentraciones como O'Ryan (1996), O'Ryan y Bravo (2001), O'Ryan y Sánchez (2007), y Mardones y Jiménez (2015). La diferencia de este estudio con los previamente mencionados es que la presente investigación evalúa cómo el impacto directo e indirecto de la dispersión de contaminantes afecta las políticas regulatorias, en términos de costos y la estimación del potencial de reducción de las fuentes industriales.

En particular este estudio compara los impactos ambientales y económicos considerando el escenario regulatorio, en el cual se asume que las emisiones de fuentes generan y reducen concentraciones solo en su propia comuna (impacto directo), así como también el escenario en el cual pueden generar y reducir concentraciones en todas las comunas (impacto directo e indirecto). La magnitud de la diferencia estará dada por los FEC que permite relacionar las emisiones de $MP_{2,5}$ en una determinada comuna, con las concentraciones de este contaminante que se generan en el resto de las

comunas. Dichos FEC fueron determinados en un estudio previo (EULA, 2014) para la zona de estudio usando el modelo de dispersión de contaminantes CALPUFF[1]. Así, es posible generar diferentes escenarios de exigencias de reducción de concentraciones por comuna para obtener los costos totales de abatimiento y determinar qué política debería implementar la autoridad medioambiental para alcanzar las exigencias de reducción al menor costo posible y proteger la salud de la población.

2. DESCRIPCION DE LA SITUACION ACTUAL

La principal fuente de información de este estudio es el Inventario de Emisiones del Concepción Metropolitano, elaborado por EULA (2014), el que contiene información de 200 fuentes industriales emisoras distribuidas en nueve comunas, identificando el nombre, la ubicación, el tipo de combustible y el nivel de emisiones de MP_{10} y $MP_{2,5}$ de cada una de ellas.

Dentro de las nueve comunas que se consideraron en este estudio, algunas de ellas se caracterizan por tener zonas industriales, concentrando una gran cantidad de fuentes emisoras, mientras otras comunas son más bien residenciales. Es por esto que existe bastante diferencia en el total de emisiones de $MP_{2,5}$ entre una comuna y otra. Como se observa en el Gráfico 1, en las comunas de Coronel y Talcahuano se concentran las mayores emisiones de $MP_{2,5}$ por el mayor número de fuentes industriales, en contraposición a comunas más residenciales, como Concepción, Chiguayante o San Pedro de la Paz.

Específicamente, Talcahuano y Coronel aportan 33,4% y 36,6%, sobre el nivel de emisiones totales en Concepción Metropolitano, mientras que otras comunas como Concepción y Chiguayante aportan 0,2% y 0,000001%.

Debido a las altas concentraciones registradas en los últimos años en esta y otras zonas de Chile, en el año 2012 comenzó a regir una normativa ambiental para material particulado fino que establece un límite máximo para las concentraciones ambientales de $MP_{2,5}$[2]. Esta norma primaria de calidad del aire establece que las concentraciones promedio anual no pueden superar los 20 $\mu g/m^3$ durante tres años consecutivos en cualquier estación de monitoreo con representatividad poblacional, rige para todo el territorio nacional y tiene por objetivo proteger a las personas de los efectos agudos y crónicos del contaminante.

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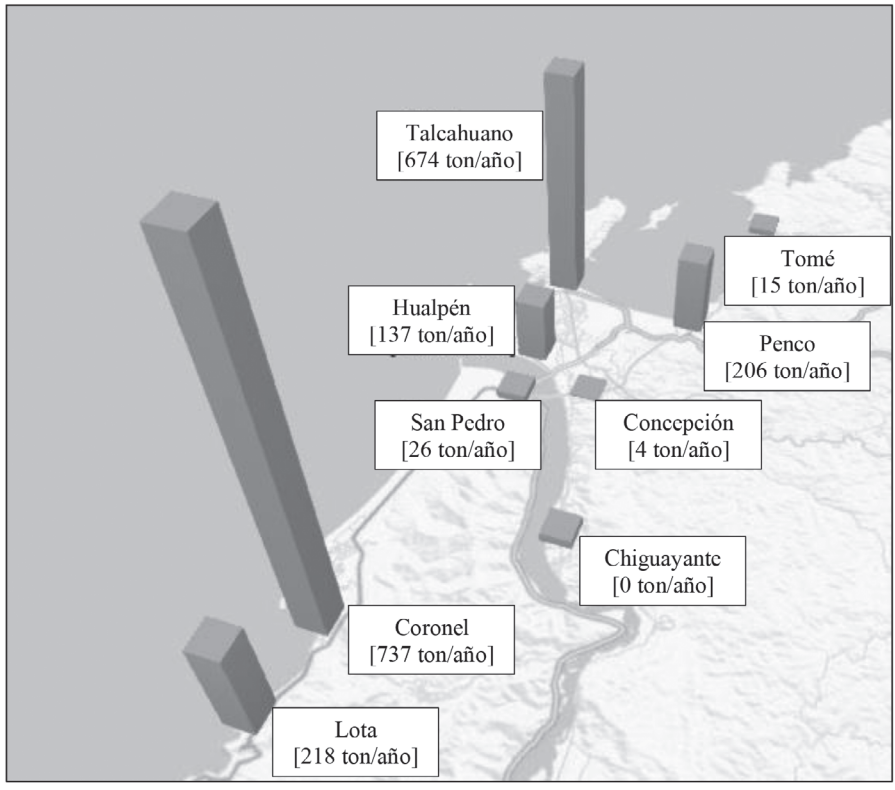
1 Es un modelo de dispersión atmosférico desarrollado por Sigma Research Corporation (parte de Earth Tech, Inc.) con la finalidad de elaborar un sistema de modelación de calidad de aire para uso regulatorio. Este *software* incluye un modelo de dispersión de contaminantes atmosféricos, un modelo de meteorología, además de módulos fotoquímicos.

2 http://www.mma.gob.cl/transparencia/mma/doc/D12.pdf

GRAFICO 1

EMISIONES DE $MP_{2,5}$ EN LAS COMUNAS DE CONCEPCION METROPOLITANO



Fuente: Elaboración propia.

3. METODOLOGIA

3.1. Tecnologías de abatimiento

En este estudio se considera como tecnologías de abatimiento apropiadas técnicamente para reducir emisiones de $MP_{2,5}$ el uso de filtro de manga, precipitador electroestático o *scrubber* del tipo lavador Venturi.

3.2. Costos y eficiencias de las tecnologías de abatimiento

Se consideran las funciones de costos para cada tecnología usadas por Ponce y Chávez (2005), las que se fundamentan en una estimación econométrica de la relación

positiva que existe entre el caudal (g/hr) de cada fuente respecto del costo anualizado de la fuente *f* para cada tecnología de fin de tubo que pueda abatir ese caudal. Sin embargo, como las funciones anteriores representan el costo total anualizado para caudales de MP_{10} fueron ajustadas y actualizadas por Mardones y Jiménez (2015), quienes incluyen factores que relacionan caudales y emisiones de MP_{10} y $MP_{2,5}$ para cada fuente $\left(t_{MP2,5f}^{MP10}\right)$. Así, en la Tabla 1 cada función finalmente representa el costo anualizado debido a la cantidad inicial de emisiones de $MP_{2,5}$ (ton/año) de una fuente particular.

TABLA 1

FUNCIONES DE COSTOS EN PESOS CHILENOS DE LAS TECNOLOGIAS DE ABATIMIENTO

Tecnología	Costo Total Anualizado ($ 2015/año)
Precipitador electrostático	$CT_f = 189110 * \left(4.213,7 * E_{MP2,5} * t_{MP2,5}^{MP10}\right)^{0,628} + 1062,2 * \left(4.213,7 * E_{MP2,5} * t_{MP2,5}^{MP10}\right) + 14924140$
Lavador Venturi	$CT_f = 78111 * \left(4.213,7 * E_{MP2,5} * t_{MP2,5}^{MP10}\right)^{0,56} + 903,5 * (4.213,7 * E_{MP2,5} * t_{MP2,5}^{MP10}) + 26816018$
Filtro mangas	$CT_f = 2526 * \left(4.213,7 * E_{MP2,5} * t_{MP2,5}^{MP10}\right)^{0,914} + 1033,1 * \left(4.213,7 * E_{MP2,5} * t_{MP2,5}^{MP10}\right) + 21736544$

Fuente: Actualización de Mardones y Jiménez (2015), basado en Ponce y Chávez (2005).

Al aplicar alguna de estas opciones, las emisiones de material particulado fino se reducen considerablemente, según el tipo de tecnología instalada y el combustible que usa la fuente industrial. Las eficiencias de abatimiento presentadas en la Tabla 2 se basan en los resultados de la ingeniería de diseño descritos por Cooper y Alley (2002) para sistemas de control de la contaminación.

TABLA 2

EFICIENCIAS DE LAS TECNOLOGIAS DE ABATIMIENTO PARA $MP_{2,5}$

Combustible	Precipitador electrostático	Filtro de mangas	Lavador Venturi
Carbón	0,90	0,96	0,92
Leña	0,90	0,99	0,92
Petróleo Nº 2	0,95	0,99	0,89
Petróleo Nº 5	0,95	0,99	0,89
Petróleo Nº 6	0,95	0,99	0,89

Fuente: Elaboración propia sobre la base de datos de Cooper y Alley (2002).

3.3. Estimación de factores de emisión-concentración (FEC)

Para conocer la relación que existe entre las emisiones de $MP_{2,5}$ y las concentraciones ambientales que estas generan, se utilizan los FEC. Este indicador permite estimar cambios en la concentración ambiental en función de cambios en las emisiones de $MP_{2,5}$ estableciendo una relación lineal entre las emisiones de un contaminante y el aporte a la concentración ambiental mediante la siguiente aproximación:

$$FEC_{i,j} = \frac{C_j}{E_i} \quad (1)$$

donde

$FEC_{i,j}$ = Factor de emisión concentración de la fuente *i* sobre el receptor *j*.
C_j = Concentración ambiental de $MP_{2,5}$ en el receptor *j*.
E_i = Emisión de $MP_{2,5}$ de la fuente *i*.

Para incluir los FEC se utilizan los valores obtenidos por EULA (2014), que los determina a partir de los registros de vientos, temperatura, humedad relativa, presión y pluviometría de las estaciones meteorológicas ubicadas en Concepción, Talcahuano y Coronel. También incluye la meteorología de altura utilizando una combinación de perfiles verticales de la atmósfera registrados dos veces al día en la estación de sondeo ubicada en Santo Domingo y las predicciones del modelo meteorológico MM5 (Modelo de Mesoescala de Quinta generación). Además, el modelo considera los datos de la calidad de aire para $MP_{2,5}$ de las estaciones de monitoreo existentes para las comunas de Concepción Metropolitano.

3.4. Modelación de las políticas regulatorias

La regulación ambiental a la cual están sometidas las fuentes industriales se puede representar con un modelo de optimización que busca minimizar los costos de implementar un sistema de permisos transable de concentraciones (también llamado sistema de permisos ambientales o APS), considerando un escenario donde las emisiones de las fuentes afecten solo su propia comuna (impacto directo) y otro en que además puedan afectar el resto de las comunas (impacto directo e indirecto). Así, en el primer escenario al exigir reducciones de concentraciones en cada comuna, solo las fuentes ubicadas ahí pueden generar dicha reducción (omitiendo el hecho de que existe un efecto indirecto en la reducción de otras comunas), mientras que en el segundo escenario las fuentes ubicadas en otras comunas también pueden aportar a la reducción.

A continuación se muestra la notación usada en el modelo:

i = Representa las 200 fuentes que pueden implementar una tecnología de abatimiento.
t = Representa el uso de tecnologías de abatimiento (lavador Venturi, precipitador electrostático y filtro de mangas). Además, se incluye la alternativa de no usar ninguna tecnología.

$X_{i,t}$ = Variable binaria que determina si una fuente *i* utiliza una alternativa del tipo *t* para la reducción de emisiones.
$C_{i,t}$ = Costo anualizado en millones de pesos chilenos de utilizar una tecnología *t* en una fuente *i.*

Considerando lo anterior, la función objetivo es de la siguiente forma:

$$Z = Min \sum_i \sum_t C_{i,t} X_{i,t} \tag{2}$$

Sujeta a las siguientes restricciones:

$$\sum_t X_{i,t} = 1 \,, \quad \forall \ \textit{fuente } i \tag{3}$$

$$\sum_i \sum_t E_i \alpha_{i,k} R_{i,t} X_{i,t} \geq RED_k \,, \quad \forall \ \textit{comuna } k \tag{4}$$

Donde,

E_i = Representa las emisiones de $MP_{2,5}$ en toneladas por año de una fuente *i.*
$R_{i,t}$ = Representa la eficiencia de reducción de emisiones de una tecnología de tipo *t* para una fuente *i.*
$\alpha_{i,k}$ = Representa los factores de emisión-concentración que relaciona las emisiones de una fuente *i* con niveles de concentración sobre la comuna *k* (se mide en microgramos/metro cúbico/toneladas/año).
RED_k = Representa la exigencia de reducción de concentraciones en microgramos por metro cúbico impuesto sobre la comuna *k* por la autoridad medioambiental.

La Ecuación 3 está asociada a la restricción que indica que cada tipo de fuente *i* debe escoger solo una alternativa *t* para controlar sus emisiones. La Ecuación 4 corresponde a los dos posibles escenarios del APS que se detallan a continuación.

a) Sistema de permisos ambientales (APS), con las emisiones de las fuentes generando concentraciones solo en su propia comuna (impacto directo): Esta restricción considera que las concentraciones reducidas por las fuentes *i* solo en la comuna *k* (en la cual están localizadas) al implementar tecnologías de abatimiento, deben ser mayores o iguales a la exigencia de reducción de concentraciones exigida en esa comuna. Esto significa asumir que será cero si la fuente *i* no está ubicada en la comuna *k*.
b) Sistema de permisos ambientales (APS), con las emisiones de las fuentes generando concentraciones en todas las comunas (impacto directo e indirecto): La restricción considera que las fuentes puedan afectar al resto de las comunas y no solo a aquella en la cual se localiza. Los FEC se modifican para determinar el impacto o concentraciones que generan las emisiones de una fuente sobre cada una de las nueve comunas.

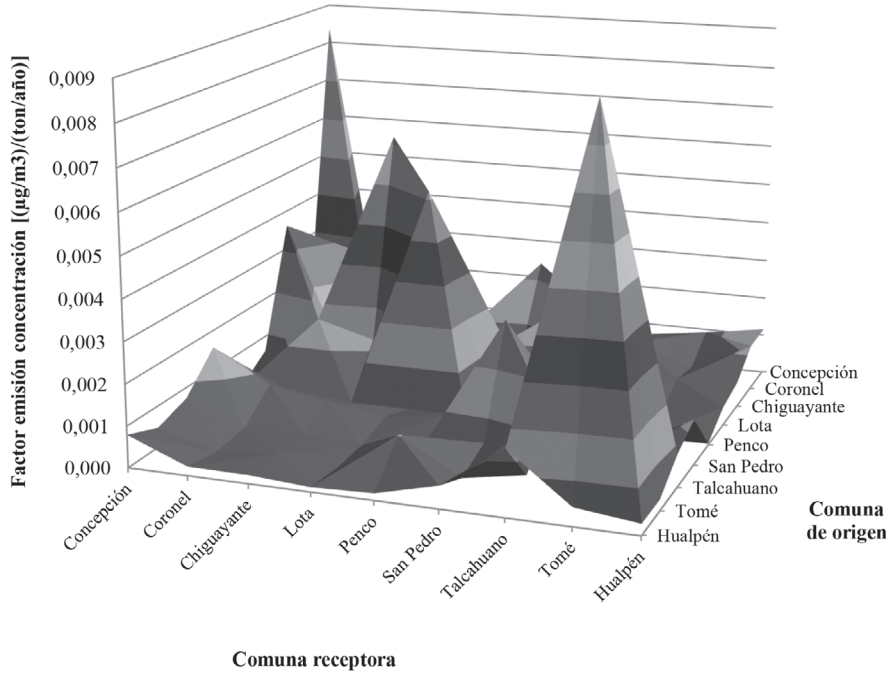
4. RESULTADOS

4.1. Factores de emisión-concentración (FEC)

El Gráfico 2 muestra los factores emisión-concentración calculados por comuna. Para el escenario donde las emisiones de las fuentes generan concentraciones solo en su comuna, se utilizan solo los FEC en la diagonal del Gráfico 2 y el resto de los valores asumen un valor cero. Por otro lado, en el escenario donde las emisiones de las fuentes afectan todas las comunas, se consideran todos los datos del Gráfico 2, es decir, las fuentes si pueden contaminar el resto de las comunas. Así, al multiplicar estos valores por las emisiones de cada fuente, se conoce su aporte a los niveles de concentraciones en cada comuna.

GRAFICO 2

FACTORES DE EMISION-CONCENTRACION AMBIENTAL
PARA LAS COMUNAS DE CONCEPCION METROPOLITANO



Fuente: EULA (2014).

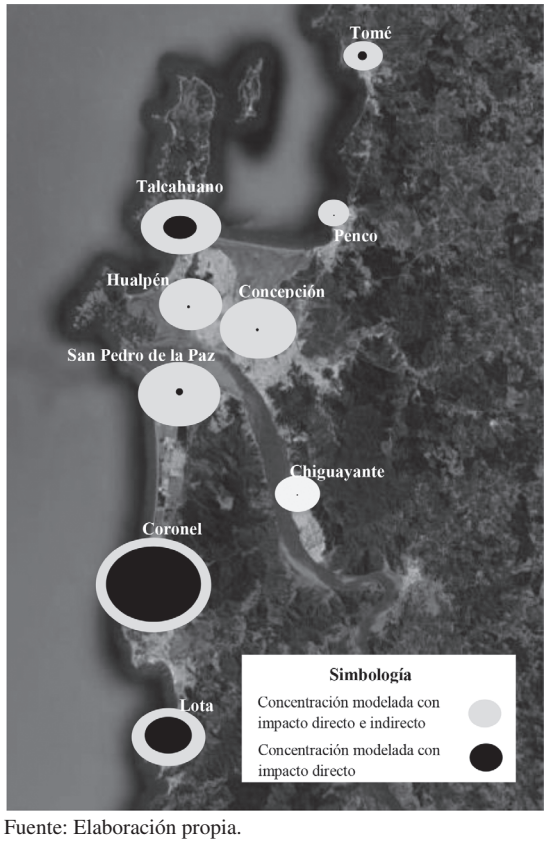
4.2. Concentraciones de $MP_{2,5}$ a partir del Inventario de Emisiones del Concepción Metropolitano

A partir del Inventario de Emisiones del Concepción Metropolitano y los FEC modelados se calculan las concentraciones aportadas por las fuentes industriales en cada una de las comunas. En primer lugar se considera que las emisiones de las fuentes generan concentraciones solo en la comuna donde se ubica y, en segundo lugar, se considera que las emisiones de las fuentes generan concentraciones en su propia comuna y en las demás.

En el Gráfico 3 se muestra la distribución geográfica de las concentraciones por comuna, considerando tanto el impacto directo como el indirecto de las emisiones de $MP_{2,5}$.

GRAFICO 3

CONCENTRACIONES MODELADAS DE $MP_{2,5}$ POR COMUNA CONSIDERANDO IMPACTO DIRECTO E INDIRECTO DE LAS EMISIONES



Fuente: Elaboración propia.

4.3. Costos de reducción considerando solo impacto directo de las emisiones

En este caso, las emisiones de las fuentes de una comuna en particular se multiplican únicamente por los FEC de la misma comuna, por lo que esas emisiones se traducen en concentraciones solo en ese lugar. Así, la Tabla 3 muestra los costos totales en millones de pesos chilenos en que incurren las comunas por alcanzar diferentes exigencias de reducción de concentraciones. Obviamente, algunas comunas no pueden alcanzar ciertas metas de reducción, ya que las fuentes industriales contribuyen menos que la meta exigida; en estos casos se considera solo el costo de la máxima meta abordable en cada comuna. También se muestra en paréntesis el costo marginal en cada comuna por aumentar las concentraciones en 0,01 μg/m^3; este costo marginal se puede interpretar como el precio sombra de incrementar 0,01 μg/m^3 en esa comuna.

TABLA 3

COSTO TOTAL EN MILLONES DE PESOS CHILENOS EN ALCANZAR LAS EXIGENCIAS DE REDUCCION CONSIDERANDO SOLO LOS IMPACTOS DIRECTOS[3]

Comuna	Unidades de concentración reducidas (μg/m^3)									Concentración total modelada (μg/m^3)
	0,02	0,22	0,43	0,65	0,87	1,08	1,30	1,51	1,73	
Chiguayante	–	–	–	–	–	–	–	–	–	0,00
Concepción	120,7 [–]	–	–	–	–	–	–	–	–	0,03
Coronel	43,7 [21,9]	480,7 [21,9]	939,6 [21,9]	1420,4 [21,9]	1920,3 [26,0]	2477,0 [27,2]	3188,3 [34,9]	3944,7 [41,0]	5756,2 [139,0]	1,94
Hualpén	485,8 [242,9]	–	–	–	–	–	–	–	–	0,04
Lota	23,1 [11,5]	253,7 [11,5]	496,0 [11,5]	749,7 [11,5]	1003,4 [11,5]	1899,2 [98,2]	–	–	–	1,13
Penco	–	–	–	–	–	–	–	–	–	0,00
San Pedro	70,4 [35,2]	–	–	–	–	–	–	–	–	0,08
Talcahuano	119,6 [59,8]	1315,9 [59,8]	2618,0 [79,3]	5318,2 [167,5]	–	–	–	–	–	0,96
Tomé	33,8 [16,9]	–	–	–	–	–	–	–	–	0,15

Fuente: Elaboración propia.

[3] El símbolo – refleja que no es técnicamente factible alcanzar la meta de concentración en esa comuna, mientras el símbolo [ ] muestra el precio sombra de transar un certificado que permita contribuir a las concentraciones en 0,01 μg/m^3.

Algunas comunas por tener una mayor concentración de $MP_{2,5}$ pueden reducir más unidades que otras. La comuna que más concentraciones atribuibles al sector industrial posee es Coronel con 1,94 μg/m^3. La siguen Lota y Talcahuano, con un aporte de 1,13 μg/m^3 y 0,96 μg/m^3, respectivamente. Por otro lado, San Pedro de la Paz, al tener una concentración total modelada de 0,08 μg/m^3, no puede alcanzar metas superiores. En el caso de Chiguayante y Penco el aporte de las concentraciones industriales es prácticamente nulo.

A medida que aumentan las exigencias de reducción, los costos tienden a aumentar, ya que es necesario que más fuentes instalen alguna tecnología de abatimiento para lograr la reducción. Además, se observan importantes diferencias de costos entre comunas por disminuir las mismas unidades de concentraciones. Esto se debe principalmente a las diferencias entre los FEC de las comunas, por lo que en algunas comunas se deben abatir más emisiones que en otras para reducir las mismas concentraciones.

Por otro lado, la cantidad de fuentes industriales que hay en cada comuna impacta los costos totales de cumplimiento, ya que al haber más fuentes en una comuna que en otra, hay una cartera más amplia de fuentes en donde el modelo de optimización puede buscar para instalar alguna tecnología de abatimiento que sea menos costosa. Así por ejemplo, para reducir 0,02 μg/m^3, Coronel tiene un costo de 43,7 millones de pesos chilenos, mientras que el costo de Concepción para la misma reducción es de 120,7 millones de pesos chilenos.

Cuando solo se considera el impacto directo, el precio sombra de 0,01 μg/m^3 es distinto en cada comuna, ya que existen tantos mercados de permisos como comunas en las cuales se puedan comprar o vender estos permisos. Como es lógico, también se observa que el precio de los permisos es más alto, cuando la meta exigida se va acercando al máximo nivel de reducción posible en cada comuna.

4.4. Costos de reducción considerando el impacto directo e indirecto de las emisiones

Los costos totales de cada una de las nueve comunas para alcanzar las exigencias de reducción de concentraciones, asumiendo que las emisiones de las fuentes afectan y reducen concentraciones en todas las comunas se presentan en la Tabla 4.

Cuando se permite que las emisiones de las fuentes afecten todas las comunas, los niveles totales de concentración en cada comuna son mayores, en consecuencia se pueden reducir más unidades de concentración debido al impacto indirecto de los FEC. Es necesario destacar que la única comuna que alcanza a reducir el máximo de concentraciones (2,38 μg/m^3) es Coronel, con un costo anual para esta comuna de 9.196 millones de pesos chilenos.

Similar a la Tabla 3, al aumentar las exigencias de reducción la tendencia general en este caso es que aumenten los costos, ya que más fuentes industriales deben instalar tecnologías de abatimiento para alcanzar las reducciones. Sin embargo, acá aparecen algunas situaciones en que los costos no son siempre crecientes, sino que también se mantienen constantes, aparecen costos cero o inclusive disminuyen.

Que los costos se mantengan constantes a pesar de aumentar las exigencias de reducción, se explica porque algunas comunas reducen sus concentraciones debido a

TABLA 4

COSTO TOTAL EN MILLONES DE PESOS CHILENOS EN ALCANZAR LAS EXIGENCIAS DE REDUCCION CONSIDERANDO IMPACTOS DIRECTOS E INDIRECTOS DE LAS EMISIONES

Comuna	Unidades de concentración reducidas (µg/m3)												Concentración total modelada (µg/m^3)
	0,02	0,22	0,43	0,65	0,87	1,08	1,30	1,51	1,73	1,95	2,16	2,38	
Chiguayante	0 [0,0]	0 [0,0]	0 [0,0]	0 [0,0]	0 [0,0]	–	–	–	–	–	–	–	1,09
Concepción	0 [0,0]	0 [0,0]	58,3 [0,0]	164,6 [0,0]	164,6 [0,0]	164,6 [0,0]	164,6 [0,0]	164,6 [0,0]	164,6 [1,1]	–	–	–	1,90
Coronel	195,4 [0,0]	2215,8 [0,0]	4212,8 [0,0]	8949,1 [0,0]	8949,1 [0,0]	8949,1 [0,0]	8949,1 [0,0]	8949,1 [0,0]	9196,0 [0,0]	9196,0 [0,0]	9196,0 [0,0]	9196,0 [25,0]	2,46
Hualpén	0 [0,0]	0 [0,0]	136,6 [0,0]	816,4 [0,0]	816,4 [0,0]	816,4 [0,0]	816,4 [0,0]	–	–	–	–	–	1,56
Lota	0 [2,4]	0 [0,0]	217,5 [0,0]	2235,6 [0,0]	2235,6 [0,0]	2235,6 [0,0]	2235,6 [0,0]	2235,6 [0,0]	2269,7 [0,0]	–	–	–	1,83
Penco	0 [0,0]	0 [0,0]	206,5 [0,0]	0 [963,4]	–	–	–	–	–	–	–	–	0,71
San Pedro	0 [0,0]	0 [0,0]	25,9 [0,0]	356,1 [0,0]	356,1 [0,0]	356,1 [0,0]	356,1 [0,0]	356,1 [0,0]	380,2 [0,0]	–	–	–	2,05
Talcahuano	0 [0,0]	0 [0,0]	0 [0,0]	6350,7 [0,0]	6350,7 [0,0]	6350,7 [0,0]	6350,7 [0,0]	6350,7 [0,0]	7832,7 [–]	–	–	–	1,98
Tomé	10,3 [18,3]	130,4 [24,2]	15,2 [10,7]	406,9 [0,0]	–	–	–	–	–	–	–	–	0,83

Fuente: Elaboración propia.

que en otra comuna se están reduciendo las emisiones, es decir, por efecto indirecto. Para el caso de las comunas de Lota y Hualpén, ambas tienen una sola fuente que explica sobre el 90% de sus emisiones, por lo que cuando la exigencia de reducción es de 0,65 μg/m^3 o superior, el modelo asigna una tecnología de abatimiento a estas fuentes grandes, porque ya no hay ninguna alternativa menos costosa. Así, para dicha exigencia y algunas siguientes, se mantiene el costo de 816,4 millones de pesos chilenos en Hualpén y 2.235,6 millones de pesos chilenos en Lota, luego de instalar estas tecnologías de abatimiento.

Aparecen costos cero cuando la comuna no incurre en costo alguno por alcanzar la exigencia de reducción, ya que otra comuna le está ayudando a reducir las concentraciones. Así, al considerar que las fuentes puedan generar y reducir concentraciones en todas las comunas, la tendencia es a intensificar la reducción en las fuentes que tienen el mayor impacto indirecto hacia el resto de las comunas, ya que permite reducir más unidades de concentraciones en más comunas a la vez.

Algo similar explica el porqué en algunos casos los costos de una comuna disminuyen al exigir mayor reducción de concentraciones. Por ejemplo, la comuna de Tomé disminuye sus costos de 130,4 a 15,2 millones de pesos al aumentar la exigencia de reducción de 0,22 μg/m^3 a 0,43 μg/m^3. Esto ocurre porque bajo la nueva meta otras comunas están aportando indirectamente con esa reducción, entre ellas Penco, Coronel, Lota, Concepción o San Pedro de la Paz, ya que estas aumentan sus costos bajo estas mismas exigencias.

Otro resultado interesante a destacar, es que cuando se considera una misma exigencia de reducción, los costos totales de las nueve comunas son menores al incluir el impacto indirecto de los FEC. Por ejemplo, para un nivel de exigencia de 0,02, en la Tabla 3 todas las comunas que pueden cumplir la meta incurren en costos por alcanzar la reducción, no así en la Tabla 4, donde aparecen comunas como Concepción, Hualpén, Lota, Penco, San Pedro de la Paz y Talcahuano con costos de reducción igual a cero. Esto se explica porque al considerar el impacto indirecto de los FEC, las reducciones de emisiones de $MP_{2,5}$ de las fuentes en Coronel y Tomé generan reducciones de concentraciones de $MP_{2,5}$ necesarias para esa meta en todas las comunas. Así, el costo total de las siete comunas que pueden alcanzar la exigencia de 0,02 μg/m^3 para el primer escenario es de 897,1 millones de pesos chilenos, mientras que para el segundo escenario es de 205,7 millones de pesos chilenos. Es necesario destacar que esta comparación de costos totales se puede realizar solo cuando se considera la misma meta de reducción de ambos escenarios, es decir, cuando las comunas en ambos escenarios pueden alcanzar las mismas reducciones, lo que no ocurre para metas más exigentes, porque no todas las comunas pueden alcanzar dichas metas.

Para la gran mayoría de los casos, el precio sombra de reducir 0,01 μg/m^3 en una comuna específica es cero. Esto se explica porque la manera más costo-efectiva para que algunas comunas poco sensibles al aporte indirecto cumplan con la meta de concentración es que las fuentes pertenecientes a la comuna que más concentraciones aporta al resto (por ejemplo, Coronel) esté abatiendo muchas emisiones. Así, se genera un exceso de reducción de concentraciones en otras comunas más sensibles,

por lo cual el costo marginal de reducir 0,01 μg/m^3 en esas comunas es cero, ya que no se requiere que ninguna fuente genere reducciones extras de emisiones.

5. CONCLUSIONES

Se comparan dos escenarios de sistema de permisos transable de concentraciones (APS). En el caso de un APS que incorpora tanto los impactos directos como indirectos, las concentraciones estimadas son mayores respecto de un APS en el que se consideran solo los impactos directos. Así, el potencial de reducción de concentraciones es mayor en el primer caso, puesto que se permite que fuentes industriales de otras comunas aporten con reducciones. Se concluye que se subestiman significativamente las concentraciones cuando el impacto indirecto no es utilizado. Para el peor de los casos, en San Pedro de la Paz se subestiman 1,97 microgramos por metro cúbico, y en el mejor de los casos, en Coronel se subestiman 0,52 microgramos por metro cúbico.

Bajo una misma meta de reducción de concentraciones, los costos de un APS con el impacto indirecto incluido son considerablemente menores a un APS sin este impacto. Además, se amplía la cartera de fuentes a la cual asignar la reducción, ya que se puede buscar la reducción en fuentes de otras comunas, que pudiesen tener costos menores de abatimiento. Principalmente, las fuentes ubicadas en las comunas que tienen un impacto indirecto más fuerte hacia el resto (mayores FEC), incrementan sus aportes y costos individuales de reducción, ya que es más eficiente en términos económicos que abatan contaminación por su propia comuna y también por las otras comunas.

La principal conclusión del estudio es que si la autoridad regulatoria no es capaz de cuantificar los efectos indirectos de las emisiones, podría exigir metas de reducción de concentraciones que no se condicen con el aporte real de las fuentes industriales. En este sentido, se podría exigir a las fuentes de cada comuna que alcancen una determinada meta de concentraciones elevando los costos de regulación, cuando la meta podría ser obtenida simplemente con la instalación de tecnologías de abatimiento en fuentes industriales de algunas comunas que tenga un importante efecto indirecto sobre las otras comunas. Por otro lado, si las fuentes industriales aportan a varias comunas no estarían internalizando los costos de su contaminación indirecta a otras comunas. Ambos casos muestran la existencia de sobre o subregulación.

Es importante destacar, que independiente de las conclusiones obtenidas en este trabajo, la implementación de un APS puede ser bastante difícil. Esto se explica porque aparte de los altos requerimientos de información sobre la dispersión de los contaminantes, los certificados emitidos en diferentes localizaciones no serán intercambiados a una tasa de uno a uno. Más bien, existirían mercados para cada localización, y cada fuente emisora cuya contaminación llegue a múltiples localizaciones tendría que transar certificados en cada localización afectada. Esto obviamente conlleva a altos costos de transacción y dificulta la implementación práctica de este sistema.

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ANEXO

A continuación se presenta la demostración que el problema que resuelve el planeador social para mantener estándares de concentración ambiental es idéntica a la solución descentralizada que resuelve cada firma si existe un sistema de permisos ambientales.

Si consideramos un área geográfica en la cual existen i fuentes emisoras (e_1, e_2,..., e_I) que afectan la concentración del contaminante q_j sobre j receptores, mediante la siguiente relación (aproximación lineal de primer orden):

$$q_j = \Sigma_i \, a_{ij} e_i + B_j$$

donde B_j es el background y a_{ij} es el coeficiente de transferencia (dq_j/de_i), también llamado factor de emisión-concentración.

El costo de controlar las emisiones de la fuente i es $C_i(e_i)$, entonces desde el punto de vista del planeador social debe minimizar los costos sujetos a mantener niveles de concentración ambiental q_j^*.

$$Min \, \Sigma_i \, C_i(e_i), \text{ sujeto a } \Sigma_i \, a_{ij} e_i + B_j = q_j^* \quad \text{con } j = 1,\ldots, J$$

$$L = \Sigma_i \, C_i(e_i) + \Sigma_j \lambda_j (\Sigma_i \, a_{ij} e_i + B_j - q_j^*)$$

Derivando respecto de e_i, las condiciones de primer orden implican que

$$C_i'(e_i) = - \Sigma_j \, \lambda_j \, a_{ij} \quad \forall i$$

Para analizar el problema descentralizado por medio de un sistema de permisos ambientales, se asume que el regulador entrega $L_j = q_j^*$ permisos para cada receptor. Después del comercio de permisos, l_i^j son los permisos que finalmente tiene cada firma. Por lo tanto, $L_j \geq \Sigma_i \, l_i^j$.

Si todos los permisos son usados y ninguno se pierde o destruye, la ecuación anterior se cumple con igualdad. La firma i emite e_i por lo que su contaminación en el receptor j será $a_{ij} \, e_i$, pero la firma solo tiene l_i^j permisos, entonces:

$$a_{ij} \, e_i \leq l_i^j \qquad \forall \, j$$

$$e_i \leq l_i^j / a_{ij} \qquad \forall \, j$$

La ecuación anterior implica que $e_i^* = min_j \{ l_i^j / a_{ij} \}$. Esto significa que las emisiones de cada firma serán limitadas por aquel receptor más sensible debido al número de permisos de la firma.

En un sistema de permisos ambientales existirá un precio diferente en cada receptor. El precio por unidad de concentración ambiental será π_j, a su vez, el precio por unidad de emisión en el receptor j es $a_{ij}\pi_j$, y además, el precio por unidad de emisión en todos los receptores es $\sum_j a_{ij}\pi_j$.

La demostración se puede obtener al resolver el problema descentralizado de cada firma. En este caso los costos totales para la firma i son:

$$CT_i(e_i) = C_i(e_i) + \sum_j \pi_j(l_i^j - L_i^j)$$

$$CT_i(e_i) = C_i(e_i) + \sum_j \pi_j(a_{ij}\, e_i - L_i^j)$$

Minimizando los costos respecto de e_i se cumple que

$$CT'_i(e_i) = C'_i(e_i) + \sum_j \pi_j a_{ij} = 0$$

$$C'_i(e_i) = -\sum_j \pi_j a_{ij}$$

Así, con $\pi_j = \lambda_j$ en cada punto de control, se obtiene de forma descentralizada la misma solución del planeador social que minimiza los costos.

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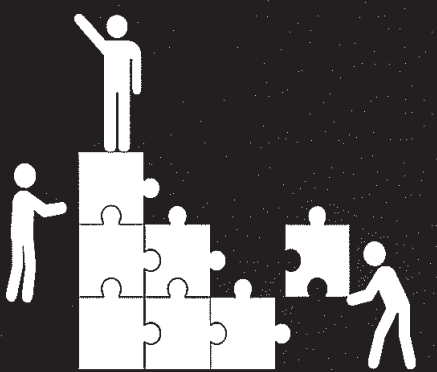

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