Banco Central de Chile
Documentos de Trabajo

Central Bank of Chile
Working Papers

N° 626

Mayo 2011

SHORT – TERM GDP FORECASTING USING BRIDGE MODELS: A CASE FOR CHILE

Marcus Cobb, Gonzalo Echavarría, Pablo Filippi, Macarena García, Carolina Godoy, Wildo González, Carlos Medel, Marcela Urrutia

Documentos de Trabajo del Banco Central de Chile
Working Papers of the Central Bank of Chile
Agustinas 1180, Santiago, Chile
Teléfono: (56-2) 3882475; Fax: (56-2) 3882231

Documento de Trabajo
N° 626

Working Paper
N° 626

SHORT – TERM GDP FORECASTING USING BRIDGE MODELS: A CASE FOR CHILE

Marcus Cobb
Banco Central de Chile

Gonzalo Echavarría
Banco Central de Chile

Pablo Filippi
Banco Central de Chile

Macarena García
Banco Central de Chile

Carolina Godoy
Banco Central de Chile

Wildo González
Banco Central de Chile

Carlos Medel
Banco Central de Chile

Marcela Urrutia
Banco Central de Chile

Abstract

The aim of this document is to provide a forecasting tool that facilitates understanding economic developments in a timely manner. This is pursued through the Bridge Model approach by using it to relate a large set of monthly indicators to Chilean GDP and its main components. The outcome is a set of simple equations that characterize reasonably well total GDP and the feasible supply- and demand-side components based on a small set of relevant indicators. The selected equations generally provide better short-term forecasts than simple autoregressive models. However, if needed, the equation selection methodology is straightforward enough to update the equations easily making it an attractive tool for real-time forecasting.

Resumen

El objetivo de este documento es proveer una herramienta de proyecciones que permita interpretar la información coyuntural a través de una metodología que relacione indicadores relevantes en frecuencia mensual con los principales componentes de la actividad y la demanda trimestral de Chile. Para esto, se sigue el enfoque de los modelos *puente* y se recurre a un conjunto importante de información. Como resultado se obtienen ecuaciones que permiten caracterizar razonablemente bien el PIB total y sus componentes factibles por el lado de la oferta y de la demanda, a partir de un conjunto acotado de indicadores. En general, estas ecuaciones entregan mejores proyecciones que simples modelos autorregresivos. Sin embargo, de ser necesario, la metodología de selección de ecuaciones es lo suficientemente simple como para que la actualización de las ecuaciones sea sencilla, y una herramienta atractiva para las proyecciones en tiempo real.

We are grateful to an anonymous referee for his or her very helpful comments.

1. Introduction

For policy makers it is very important to have a timely assessment of the current economic conditions. Their decisions greatly depend on these assessments and therefore require considering large amounts of information that often is not fully available when needed. In the case of Chile, the first release of GDP is only available two months after the quarter has ended. This means that acquiring information regarding economic activity from other more timely sources is a necessity.

In such an environment, analysts typically resort to more narrow scoped monthly indicators to infer the developments of this broad measure. This and the increasing availability of real time information has meant that the forecaster needs not only to build a framework to predict the behaviour of the variables of interest but also sieve through his set of indicators separating the information that is useful from that which is not.

In this context, different approaches have been developed to try to make the most out of monthly indicators. One of these is that of the compound indicators, like those published by NBER and OECD, where the filtered versions of a reduced number of high frequency variables are used to establish changes in the economic cycle (Stock and Watson, 1998; Altíssimo et al., 2001). A different approach is that of the dynamic factor models, where few generalized underlying and unobservable movements that influence the entire economy are extracted from a large set of variables and then used to aid the forecasting of specific variables. This sort of models has mostly followed the implementation of Stock and Watson (2002a, b) or Forni et al. (2005) and has claimed a fair amount of attention and a degree of success (Ziegler y Eickmeier, 2006). A third approach is that of the Bridge Models (Rünstler and Sédillot, 2003; Baffigi et al., 2004; Diron, 2008; Barhoumi et al., 2008a, b) where a reduced number of monthly variables are related to GDP through a quarterly (bridge) equation by lowering the frequency of the monthly data.

In this paper we provide a short-term forecasting framework for Chiles GDP relying on this third approach. The simplicity of the Bridge Models approach allows for a relatively straightforward interpretation that could prove to be valuable when communicating policy decisions.

However, this simplicity bears the cost of conditioning its success to the selection of independent variables. To circumvent this problem as much as possible we resemble closely the model developed by Barhoumi et al. (2008a, b) for France, where they define the relevant bridge equations stating from a large dataset and systematically discard the useless information through a predetermined procedure. In doing so, in line with Pesaran and Timmerman (2005), they emphasize the importance of automatic model selection and the prevention of data snooping when developing real-time forecasting tools.

Adhering to this framework, quarterly bridge equations are generated for GDP and its main demand and supply-side components. The equations provide a framework to produce real-time estimates of contemporary unreleased GDP (*nowcast*) and forecast the following quarter. In Section 2 the relevant-variable selection strategy and the equation selection procedure are presented. Section 3 explains the empirical application of the selected equations. Section 4 presents an out-of-sample exercise and section 5 sums up the main results.

2. *Selection of Bridge Equations*

2.1. Variables of interest

The main objective of Bridge Models is to make the most of the information contained in timely indicators to generate a useful estimate of certain variables of interest for which the relevant information is still unavailable. Economic activity measured by GDP is an obvious candidate as, in Chile at least, it is released for the first time two months after the quarter has ended. This publication lag means that many potentially useful monthly indicators should be readily available at the moment of estimation.

In this context, it is also of interest to provide timely estimates for the main components of GDP, as it could facilitate the explanation of certain economic developments. This can serve a purpose when it comes to communicate policy decisions and also allow checking for consistency, but overall it may be easier to contrast the results of the different sectors (or components) with expert knowledge rather than to attempt to do this for GDP as a whole. However, with this in mind, sufficient relevant information may be attainable only for certain components making it unproductive to attempt to build an exhaustive Bridge Model.

Table 1: Selected Components

	Relative weight in 2009
Total GDP	100%
Demand:	
Total private consumption	69%
Private consumption of non durable goods	62%
Private consumption of durable goods	7%
Government Expenditure	13%
Gross fixed capital formation: machinery and equipment	11%
Export of goods and services	38%
Import of goods and services	44%
Supply	
Industry	15%
Commerce	10%
Construction	7%

In this implementation priority was given to those components with a larger relative weight and those more directly related to the economic cycle. On the supply side of GDP, the chosen sectors were those most affected by demand shocks. This meant excluding the sectors related to natural resources (mining, fishing and electricity, gas and water). Both some public and private services were also excluded due to the lack of relevant indicators. On the demand side, most of the components were included.

2.2. Procedure for the selection of bridge equations

Having selected the variables of interest, attention was drawn to the large set of available information. The nature of the Bridge Models meant that, as opposed to dynamic factor models that use the entirety of the large set of information, necessarily a selection process had to take place to reduce the dimensionality of the problem at hand.

As it was said before, the success of the approach would greatly depend on this procedure and therefore care should be taken to avoid artificially improving in-sample fit of the forecasting method through data snooping (Pesaran and Timmerman, 2005).

With this in mind, the primary equation selection path followed the purpose set forth in Barhoumi et al. (2008a, b) that was to reduce as much as possible the subjectiveness in the selection of equations. This was pursued by explicitly using statistical tests and relying on the automatic general-to-specific approach implemented in PCGets (Hendry and Krolzig, 2001). This method, as described in Hendry and Nielsen (2007), starts from the broadest sensible specification and through a search algorithm follows multiple paths to remove irrelevant variables based on statistical tests.

Given the large number of series (approximately 300) and the limited time span, a reduction of the number of series that entered the automatic procedure had to be performed. The initial selection followed the following criterion: (1) High correlation with the variable of interest and low correlation with the variables already selected. (2) In line with Golinelli and Parigi (2007) monthly series that are available more promptly, suffere smaller or no revisions and are economically justifiable were preferred.

It is worth mentioning, at this point, that the outlined strategy does not seek to establish causal relations between variables. The approach tries to exploit the co movements that economic variables tend to display and therefore even when economic rational may be present on occasions, it may not always be the case. With this in mind, special attention was paid to make the implementation easy to update as statistical relations may erode over time and the development of new indicators may require the equations to be revised.

Taking this into consideration, a second supplementary path was also explored. Using the automatically selected equations as a starting point, variables that *a priori* were expected to have predictive power were added. Then, from this extended specification, variables selected automatically that became statistically irrelevant were then discarded. The idea of specifying these supplementary equations was to acknowledge the possibility that expert judgment could lead to a better characterization of the equations and that some economically relevant variables could have been dominated by other correlated but less intuitive variables. Following such a strategy obviously introduced an element of subjectivity to the process; however, it may provide more support to eventual economic interpretation. It would also provide a yardstick to judge the relative efficiency of the purely automatic selection process.

For both paths, monthly variables were taken to quarterly frequency acknowledging whether they are flow or stock variables. Also, as a departure from Barhoumi et al. (2008a, b), quarterly independent variables were also included. It is worth noting that at the coefficient estimation stage, full information was assumed and therefore publication lag was not considered at that point.

Following the aforementioned strategy and after discarding any unstable specifications, two quarterly equations were defined relating the independent variables and their lags

(X_t, X_{t-1}, …) with each contemporaneous variable of interest (Y_t): the automatic equation and the judgment equation.

3. *Empirical application*

3.1. Data

The initial dataset consisted of the 10 variables of interest and a large set of potentially useful indicators (approximately 300 series). Due to the nature of the variables of interest all were seasonally adjusted using X12-ARIMA (U.S. Census Bureau, 2007) and set in differences of their logarithms. Accordingly, the set of explanatory variables were checked for seasonal behaviour and were seasonally adjusted if needed. The program TRAMO (Gomez and Maravall; 1997, 1998) was used to check whether the logarithmic transformation was more appropriate than the original measure. This procedure resulted in that generally all variables were put in logarithms except for those expressed as rates or in percentages. This is in line with previous large dataset literature (Camacho and Sancho, 2003; Stock and Watson, 2002a). Variables that showed non-stationary behaviour were rendered stationary by differentiation. The exact transformations of the series included in the equations are summarized in Annex1.

3.2. Selection of final bridge equations

Due to the nature of the exercise the equations were expressed to forecast quarterly growth of the variables of interest. As it was mentioned before, the independent variables for each bridge equation were selected through a broad strategy that seeked to avoid the inclusion of irrelevant data and reduce multicollinearity, but also care was taken to provide economic intuition through the inclusion of equations based on expert knowledge. Also, series that were published in a timely fashion and that were less subject to revision were preferred. The estimation sample was 1996-2007 leaving two years (2008-2009) for the purpose of out-of-sample evaluation.

Due to the number of components, the actual specification of the equations for all the variables of interest and the relevant in sample statistics are presented in Annex 2. To exemplify the outcome of the outlined strategy, the resulting equations for total GDP are the following:

Primary Equation:

$$\Delta y_t = -0.51\Delta y_{t-2} + 0.28\Delta fy_{t-2} + 0.17\Delta iis_t + 0.35\Delta elec_t$$
$$+0.31\Delta M3_{t-1} + 0.05\Delta stx_{t-2}$$

Supplementary Equation:

$$\Delta y_t = -0.49\Delta y_{t-2} + 0.35\Delta fy_{t-1} + 0.33\Delta rs_t + 0.33\Delta elec_t$$
$$+0.25\Delta M3_{t-1} + 0.05\Delta govex_{t-1} \ ,$$

where y is total GDP; fy is industrial production of the U.S., E.U. and Japan; iis is intermediate industrial sales; $elec$ is electricity generation; $M3$ is the respective money stock; stx is stock exchange index; rs is retail sales; $govex$ is government expenditure. All of the variables are in logarithms.

As it can be appreciated, the supplementary equation includes two additional variables and on the other hand drops two. The idea behind "forcing" the inclusion of government expenditure was that it would be desirable for the equation to pick up eventual fiscal shocks even when it was not automatically selected. Also, intermediate industrial sales were swapped for real sales due to some information overlap with electricity generation. As a result of the incorporation of these two variables the stock exchange index ceased to be informative.

In the following paragraphs a brief overview is sketched out. It is worth noting that in this overview the influence of the variables are treated rather loosely meaning the exact transformation should be checked in Annex 1.

3.2.1. Supply-side components.

The selected equations show that many independent variables appear with considerable lags. For example, industrial production of developed countries appears both in Total GDP and in the industrial sector as an indicator of foreign demand, something that seems reasonable for the tradable sectors. From a financial perspective, money stock (M3) appears in Total GDP and commerce, suggesting short-run influence of the nominal variables. Lending interest rates affect industry and construction negatively, while the Stock Exchange index has some predictive power on Total GDP with a two quarter lag suggesting leading indicator properties. For the different sectors, months to exhaust the stock of houses serve as a predictor for construction. The real exchange rate affects negatively commerce and industry. While the first may be explained as a reflection of importing sector's margins the effects on industry seems a bit counterintuitive. Variables such as generation of electricity in Total GDP, sector indicators from the statistical office for construction, industry and commerce appear as contemporaneous predictors.

3.2.2. Demand-side components.

For private consumption some financial variables appear to have leading predictive ability (interest rate and total lending) as do consumer expectation collected by the respective survey. However, most of the selected variables appear contemporaneously. Again, for private consumption, many partial indicators like supermarket sales seem relevant. For gross fixed capital formation of machinery and equipment and for import of goods and services, the indicators of imports of capital stock dominated in the automatic selection. In the judgment equation other variables such as real exchange rate, interest rate and industrial production were added. Government expenditure would be dominated by the value added of public administration.

3.3. Timing of the forecasting procedure

The framework is built for a monthly forecasting context and more precisely seeks to estimate the present value of the unpublished variable of interest and forecast it one step ahead. Be as it may, at times not even the previous value of GDP will be known and therefore it will also have to be estimated. The current publication lag pattern means that for each quarter 8 estimates or forecasts will have been made before the first release is published.

The dynamics of the exercise starting in January 2010 (and the eight estimates for 2010.II) is outlined in Figure 1 and goes as follows:

1. Having just ended January 2010, the contemporaneous quarter would be 2010.I and 2010.II the one step-ahead forecast. The last available GDP figure would have been 2009.III and, therefore, 2009.IV would also need to be estimated.
2. Having just ended February 2010, a second forecast for 2010.II would be done as for 2009.IV and 2010.I.
3. Having just ended March 2010, a third forecast for 2010.II would be done and only 2010.I would need to be estimated. This due to the fact that 2009.IV would have just been published.
4. Having just ended April 2010, the contemporaneous quarter would now be 2010.II and the one step-ahead forecast 2010.III.

⋮

8. Having just ended August 2010, the last estimate for 2010.II would be done as it would be published during September.

Figure 1
Publication and Forecasting Dynamics

Present quarter	Last available GDP	Ended month	Past estimation	Contemporaneous estimation	One step ahead forecast
⋮	⋮	⋮	⋮	⋮	⋮
	2009.III	1	2009.IV	2010.I	**2010.II**
2010.I		2	2009.IV	2010.I	**2010.II**
		3	.	2010.I	**2010.II**
	2009.IV	4	2010.I	**2010.II**	2010.III
2010.II		5	2010.I	**2010.II**	2010.III
		6	.	**2010.II**	2010.III
	2010.I	7	**2010.II**	2010.III	2010.IV
2010.III		8	**2010.II**	2010.III	2010.IV
		9	.	2010.III	2010.IV
⋮	⋮	⋮	⋮	⋮	⋮

It should become fairly obvious that in an actual forecasting environment the set of independent variables will be far from complete most of the time. This will be especially the case of the mid quarter months, like February for example, where unavoidably at least all the information that completes the respective quarter will be lacking. Following Barhoumi et al. (2008a) the missing information is completed utilizing auxiliary models and subsequently is replaced by the "real" data as soon as it becomes available. Regarding this strategy Golinelli and Parigi (2007) find that, in this framework, more complex models do not improve forecasting accuracy over simple autoregressive models and in occasions have a detrimental effect. Taking this into account, for the implementation presented in this paper we rely on the TRAMO program (Gomez and Maravall; 1997, 1998) and its automatic SARIMA selection procedure to forecast the unavailable observations in the monthly series. This permits filling in the least possible amount of data, as opposed to forecasting the quarterly series, and should mean an increase in forecasting accuracy of the bridge equations as the actual data becomes available on a monthly basis.

3.4. Pseudo-real-time forecasting exercise

As it was previously pointed out the time span reserved for forecast evaluation purposes covered 2008 and 2009. This selection is particularly interesting, as the mentioned evaluation period includes the most recent global financial crisis. Having avoided this period on the one hand, for estimation purposes, reduced the chances of artificially inflating the models' fit due to the generalized downturn. On the other hand, for evaluation purposes, it contained a shock sufficiently large to highlight the potential benefits of preferring the proposed approach over the autoregressive benchmarks.

3.4.1. Set up

The goal of this paper is to provide a tool that may provide useful information to take decisions when a wholly informed assessment of the economic situation is not possible. Therefore, an evaluation exercise, to be useful, should replicate the conditions a forecaster would face in such an environment. The estimation of the equations was performed assuming full contemporary information; however, this would rarely be the case when there are multiple sources of information. For the purpose of this evaluation, the publication lag pattern of the independent variables was replicated and the resulting missing information was filled in with the forecasts of the SARIMA models chosen by TRAMO, just as it would have been done if the data was truly unavailable.

The evaluation period spans from 2008.I to 2009.IV, meaning the forecasting procedure was repeated recursively 24 times providing that number of contemporary estimates (nowcasts) and one-step-ahead forecasts and 16 past value estimations. It is worth mentioning that the number of relevant new series and the amount of data required to make estimation feasible contributed to make the evaluation period relatively short, however, as it was pointed out the evaluation period remains particularly interesting.

It is worth mentioning that the exercise did not consider the problem arising from data revisions (data vintages) meaning it was not a fully real-time exercise. While Diron (2008) finds that this problem is not of much relevance for Europe at least, it is worth having it in mind especially because statistics in other countries could suffer greater revisions. In particular, the importance of this matter will depend on the magnitude of the revisions, the speed of convergence to the actual value and what is expected from the forecasting tool. If the goal of the exercise is to predict first releases then the value of this one is arguable. However, the goal of this framework is to provide an assessment of the real economic situation and therefore it should aim to forecast final values. With this in mind, the forecaster should be aware that using final vintages of the independent variables could overstate the accuracy of the method.

3.4.2. Results

The performance of the different equations, measured by root mean square forecasting error (RMSFE) of the yearly change, is presented in Annex 3 and the accuracy of the forecasts are compared to those generated by a benchmark model. To make the comparison more challenging and comparable to an actual real-time forecasting environment, the benchmark is a SARIMA chosen by the program TRAMO every period.

The forecasts are presented from one to three steps ahead from the perspective of the variable of interest. This means that when a past value of GDP is not available $h=1$ represents the estimate of this unreleased figure, $h=2$ the contemporaneous estimation and $h=3$ the one-step-ahead forecast. When the past value has been published, $h=1$ represents the contemporaneous estimation and $h=2$ the one-step-ahead forecast.

The comparison shows that, in general, the bridge equations outperform the SARIMA benchmarks. This suggests that incorporating monthly information can contribute to more accurate forecasts. On the one hand, the automatically selected equations generally perform reasonably well. On the other, in most cases the contribution of the expert is positive and this is most noticeable in the more volatile components. One example where the judgment based equations perform better than the others (benchmark and automatic equation) is gross fixed capital formation of machinery and equipment. This relative better performance is partially backed by the modified Diebold-Mariano test (Diebold and Mariano, 1995; Harvey, Leybourne and Newbold, 1997) for the demand side supplementary equations at least. However, as one might expect, the forecast accuracy from the primary and supplementary equations are not significantly different according to the test.

4. Conclusions

Using the methodology sketched out by Barhoumi et al. (2008a,b) as a starting point, we find that a relatively small number of series have a positive contribution on the prediction of activity and demand variables. The evaluation shows that the presented bridge models outperform the quarterly autoregressive benchmarks over the 2008.I – 2009.IV period. This is particularly promising given the fact that the utilized coefficients where estimated with data up to 2007 and therefore excluding the 2008 global financial crisis. This suggests that Bridge Models could be particularly useful in turbulent times when the natural inertia of the relevant series could be disrupted. However, not much can be said about whether this predictive "advantage" over autoregressive models holds in more stable times.

The main contribution of this paper is, first, to give evidence in favour of bridge models as a useful tool to have in the forecaster's toolbox, and second, to provide a framework on which to work on for future refinements. The fact that statistical relations and co movements can erode over time means that these particular equations are not intended to be considered as "carved in stone", but as a starting point. The way the selection strategy has been sketched out means that estimating the equations should not require a massive effort, but in fact could be quite easily implemented to permit the equations to be reviewed often and updated if necessary. However, the same (or more) care that was taken when estimating these initial equations should be taken in the updating process as blind faith in a methodology is rarely a desirable thing. Having said this, preliminary work on incorporating the financial crisis period into the estimation showed that most of the specifications were relatively stable; however the automatic selection procedure suffered in some cases probably due to the generalized downturn.

Further research should contemplate an evaluation in stable times, comparing Bridge Models to more sophisticated methods and also evaluate the effect on forecasting accuracy of recursive coefficient estimation as opposed to fixed. An additional move could include trying alternative transformations for key independent variables. Also, many interesting potentially useful series were ignored due to their relative newness and should be considered when they become long enough to be incorporated into the modelling strategy.

On a final note it is worth mentioning that comparing the models forecasts to first releases should be done taking into account that the model's aim is to predict the final release or more specifically the real value. Regarding this point Golinelli and Parigi (2005) find that better estimation of final values can be achieved by combining the first release with forecasts.

Annex 1: Data transformation and definitions

Mnemonic	Transf	Description
PIB	d.log	Total GDP
ind	d.log	Industry
com	d.log	Commerce
cons	d.log	Construction
cp	d.log	Total private consumption
cp_hab	d.log	Private consumption of non durable goods
cp_dur	d.log	Private consumption of durable goods
cgov	d.log	Government Expenditure
mye	d.log	Gross fixed capital formation: machinery and equipment
xbys	d.log	Export of goods and services
mbys	d.log	Import of goods and services
ext115	d.log	Industral prod. U.S., E.U. and Japan
act47	d.log	Intermediate industrial sales
act12	d.log	Electricity generation
fin23	d.log	M3
fin37	d.log	Chilean Stock Exchange
dem10	d.log	Retail sales
fis5	d.log	Government expenditure
fin58	d.log	Real exchange rate
act22	d.log	Industrial production
fin48	d	Real interest rate: 90 days to 1 year
act2	d.log	Served cement orders
act21	d.log	Index of real sales of construction material
dem40	d.log	Housing sales
edif01	d.log	Building permits
mesagoviv	d.log	Months to sell housing stock
ml32	d.log	Total employment
cbc	d.log	Investment survey
ipec50	level	Economic perspective survey
bolsa	d.log	Real stock exchange Index
act40	d.log	Phisical sales manufacturing sector
dem1	d.log	Supermarket sales
dem3	d.log	Retail sales of non-durables
fin49	d.log	Nominal interest rate: 90 days to 1 year
act42	d.log	Industrial sales
ypd	d.log	Private disposable income
coloc	d.log	Total lending for consumption
dem5	d.log	Retail durable sales
ml38	d.log	Employment in non-financial services
va_per	d.log	Value Added: personal services
va_adm	d.log	Value Added: public administration
ext11	d.log	Import of capital goods
ipe	d.log	Foreign price index
def_PIB/MyE	d.log	GDP deflactor / GFCF M&E deflactor
prc8	d.log	5 year Central Bank real bonds
act15	d.log	IMACEC
ext8	d.log	Consumption imports
ext9	d.log	Rest imports
act48	d.log	Capital goods sales
act21	d.log	Index of real sales of construction material
ext116	d.log	U.S. GDP
xb_bal	d.log	Real export of Goods

Annex 2a: Supply-side bridge equations

Total GDP

Primary equation:

	Coeff	StdError	t-value
PIB(-2)	-0.5174	0.1160	-4.46
ext115(-2)	0.2797	0.1158	2.42
act47	0.1663	0.0476	3.49
act12	0.3490	0.0996	3.51
fin23(-1)	0.3126	0.0705	4.43
fin37(-2)	0.0493	0.0169	2.91
RSS	0.0010	Radj^2	0.60

Supplementary equation:

	Coeff	StdError	t-value
pib(-2)	-0.4903	0.1694	-2.89
ext115(-1)	0.3457	0.0815	4.24
dem10	0.3255	0.1031	3.16
act12	0.3305	0.1084	3.05
fin23(-1)	0.2472	0.0928	2.66
cgov(-1)	0.0523	0.0268	1.95
RSS	0.0025	Radj^2	0.42

Industry

Primary equation:

	Coeff	StdError	t-value
fin58(-1)	-0.0928	0.0475	-1.95
act22	0.0077	0.0009	8.93
RSS	0.0058	Radj^2	0.59

Supplementary equation:

	Coeff	StdError	t-value
fin58(-1)	-0.1309	0.0413	-3.17
fin23(-1)	0.0911	0.0312	2.92
act22	0.0078	0.0006	13.67
RSS	0.0076	Radj^2	0.63

Commerce

Primary equation:

	Coeff	StdError	t-value
dem10	0.3502	0.0934	3.75
dem10(-1)	0.2012	0.0858	2.35
fin23(-2)	0.2358	0.0562	4.20
fin58(-1)	-0.1304	0.0451	-2.89
act2	0.1646	0.0341	4.83
RSS	0.0058	Radj^2	0.64

Construction

Primary equation:

	Coeff	StdError	t-value
act2	0.2714	0.0800	3.39
act21	0.2256	0.1021	2.21
dem40	0.0623	0.0216	2.89
RSS	0.0055	Radj^2	0.48

Supplementary equation:

	Coeff	StdError	t-value
edif01(-1)	0.0273	0.0128	2.13
mesagoviv	-0.0447	0.0200	-2.24
mesagoviv(-1)	-0.0491	0.0197	-2.50
ml32	0.6596	0.1004	6.57
act21	0.2207	0.0669	3.30
cbc(-2)	0.0637	0.0192	3.32
cbc(-3)	0.0471	0.0206	2.29
RSS	0.0010	Radj^2	0.72

Annex 2b: Demand-side bridge equations

Total private consumption

Primary equation:

	Coeff	StdError	t-value
cp(-1)	0.3045	0.0820	3.71
act40	0.2305	0.0570	4.05
dem1	0.2945	0.0723	4.07
dem10	0.5215	0.0946	5.51
fin48	-0.0021	0.0008	-2.85
ipec50	0.0002	0.0001	2.75
cgov	0.0787	0.0431	1.83
dem3	-0.3746	0.0915	-4.09
RSS	0.0014	Radj^2	0.72

Supplementary equation:

	Coeff	StdError	t-value
Constant	0.0137	0.0016	8.37
ipec50	0.0004	0.0001	3.95
bolsa(-1)	0.0299	0.0168	1.78
fin49(-1)	-0.0365	0.0135	-2.71
RSS	0.0037	Radj^2	0.33

Private consumption of non durable goods

Primary equation:

	Coeff	StdError	t-value
Constant	0.0092	0.0011	8.65
fin48	-0.0021	0.0008	-2.70
fin48(-2)	-0.0027	0.0008	-3.50
ipec50(-2)	0.0002	0.0001	3.50
act42	0.2660	0.0486	5.47
act42(-2)	0.2103	0.0493	4.27
RSS	0.0014	Radj^2	0.52

Supplementary equation:

	Coeff	StdError	t-value
Constant	0.0125	0.0012	10.05
ipec50(-1)	0.0003	0.0001	3.32
fin49(-1)	-0.0325	0.0104	-3.14
RSS	0.0023	Radj^2	0.25

Private consumption of durable goods

Primary equation:

	Coeff	StdError	t-value
ypd(-1)	0.2176	0.1679	1.30
coloc	0.6839	0.1751	3.91
dem5	0.5354	0.1419	3.77
RSS	0.0674	Radj^2	0.48

Supplementary equation:

	Coeff	StdError	t-value
Constant	0.0260	0.0079	3.31
ipec50	0.0022	0.0005	4.07
bolsa(-1)	0.1890	0.0805	2.35
fin49(-1)	-0.1255	0.0648	-1.94
RSS	0.0848	Radj^2	0.34

Government Expenditure

Primary equation:

	Coeff	StdError	t-value
cgov(-1)	0.3246	0.1073	3.02
ml38(-1)	0.1328	0.0539	2.47
va_per	0.3191	0.1026	3.11
va_adm	0.6089	0.1987	3.06
RSS	0.0008	Radj^2	0.47

Supplementary equation:

	Coeff	StdError	t-value
cgov(-1)	0.3832	0.1291	2.97
cgov(-2)	0.1716	0.1418	1.21
cgov(-3)	-0.1889	0.1401	-1.35
cgov(-4)	-0.1826	0.1390	-1.31
ml38(-1)	0.1064	0.0551	1.93
va_per	0.3559	0.1066	3.34
va_adm	0.8299	0.2391	3.47
RSS	0.0007	Radj^2	0.48

Annex 2b (continued): Demand-side bridge equations

Gross fixed capital formation: machinery and equipment

Primary equation:

	Coeff	StdError	t-value
ext11 - ipe	0.6492	0.0579	11.20
def_PIB/MyE	0.4247	0.1290	3.29
RSS	0.0683	Radj^2	0.74

Supplementary equation:

	Coeff	StdError	t-value
Constant	0.0577	0.1256	0.46
log(mye/PIB)(-1)*	-0.1101	0.0411	-2.68
fin58(-1)	-0.0028	0.0015	-1.81
prc8(-1)	-0.0184	0.0085	-2.17
ext11	0.5632	0.0640	8.80
act15(-1)	1.2112	0.5730	2.11
RSS	0.0591	Radj^2	0.75

(*) cointegrating relation of the levels of the variables

Export of goods and services

Primary equation:

	Coeff	StdError	t-value
xbys(-1)	-0.4128	0.1324	-3.12
act40	0.7656	0.2826	2.71
ext116(-1)	2.1345	0.5938	3.59
RSS	0.0157	Radj^2	0.39

Supplementary equation:

	Coeff	StdError	t-value
xbys(-1)	-0.1585	0.0822	-1.93
ext116(-1)	1.4937	0.3601	4.15
xb_bal	0.4714	0.0564	8.36
fin58	0.0666	0.0673	0.99
RSS	0.0052	Radj^2	0.79

Import of goods and services

Primary equation:

	Coeff	StdError	t-value
ext11 - ipe	0.1213	0.0397	3.31
ext8	0.1476	0.0529	2.79
ext9	0.1874	0.0786	2.39
act48	0.0483	0.0195	2.47
act21	0.2623	0.0990	2.65
RSS	0.0196	Radj^2	0.66

Supplementary equation:

	Coeff	StdError	t-value
Constant	0.0121	0.0034	3.54
ext11	0.1529	0.0390	3.92
ext8	0.2075	0.0502	4.13
ext9	0.1820	0.0855	2.13
RSS	0.0197	Radj^2	0.67

Annex 3: Out-of-Sample forecasting evaluation:

Root mean square forecasting error of the yearly growth rate.

(2008.I a 2009.IV period)

Primary Equation

	Mean v12*	SD. v12*	**Absolute RMSFE:** SARIMA:			Abs.RMSFE **Eq1 (PcGets)**			Relative (model / SARIMA)		
			h=1	h=2	h=3	h=1	h=2	h=3	h=1	h=2	h=3
Supply											
GDP	1.7	3.6	1.7	3.5	4.5	2.1	3.3	3.2	1.2	1.0	0.7
Construction	2.2	7.7	4.7	7.4	8.4	4.1	5.8	5.7	0.9	0.8	0.7
Commerce	3.5	7.4	3.9	6.5	8.5	2.7	3.7	5.7	0.7	0.6	0.7
Industry	-2.8	5.3	3.6	5.9	7.0	3.4	4.9	5.2	1.0	0.8	0.7
Demand											
Private Consumption	4.1	4.1	2.3	3.8	4.7	2.0	2.7	3.5	0.9	0.7	0.7
Non-durable	3.8	2.0	1.7	2.4	2.9	1.2	1.6	2.0	0.7	0.7	0.7
Durable	7.2	21.8	11.4	18.7	23.9	9.7	16.3	20.7	0.8	0.9	0.9
Gov't Expenditure	3.3	3.2	3.1	5.0	5.6	2.6	3.8	3.5	0.8	0.7	0.6
GFCF: Machinery and Equipment	10.4	32.7	17.3	29.2	38.3	13.1	25.1	34.9	0.8	0.9	0.9
Import of Goods and Services	4.2	17.7	8.0	14.6	19.3	2.8	9.1	15.7	0.4	0.6	0.8
Export of Goods and Services	-1.5	4.8	6.0	8.6	9.8	4.5	5.9	5.2	0.7	0.7	0.5

Supplementary Equation

	Mean v12*	SD. v12*	**Absolute RMSFE:** SARIMA:			Abs.RMSFE **Ec2 (judgment)**			Relative (model / SARIMA)		
			h=1	h=2	h=3	h=1	h=2	h=3	h=1	h=2	h=3
Supply											
GDP	1.7	3.6	1.7	3.5	4.5	1.5	2.4	3.2	0.9	0.7	0.7
Construction	2.2	7.7	4.7	7.4	8.4	3.1	5.9	7.5	0.7	0.8	0.9
Commerce	3.5	7.4	3.9	6.5	8.5						
Industry	-2.8	5.3	3.6	5.9	7.0	2.8	3.9	4.7	0.8	0.7	0.7
Demand											
Private Consumption	4.1	4.1	2.3	3.8	4.7	1.8	2.6	2.6	0.8	0.7	0.6
Non-durable	3.8	2.0	1.7	2.4	2.9	1.3	1.7	1.6	0.8	0.7	0.5
Durable	7.2	21.8	11.4	18.7	23.9	8.5	12.7	15.6	0.7	0.7	0.7
Gov't Expenditure	3.3	3.2	3.1	5.0	5.6	3.0	4.4	4.1	0.9	0.9	0.7
GFCF: Machinery and Equipment	10.4	32.7	17.3	29.2	38.3	6.7	15.1	23.8	0.4	0.5	0.6
Import of Goods and Services	4.2	17.7	8.0	14.6	19.3	3.4	9.7	16.3	0.4	0.7	0.8
Export of Goods and Services	-1.5	4.8	6.0	8.6	9.8	3.9	6.3	6.4	0.7	0.7	0.7

shaded areas mark forecasts that outperform the SARIMA according to a one-sided modified Diebold-Mariano test at a 5% confidence level

* calculated over de evaluation period only.

References:

Altissimo, F., A. Bassanetti, R. Cristadoro, M. Forni, M. Hallin, L. Reichlin y G. Veronese (2001). "EuroCOIN: A Real Time Coincident Indicator of the Euro Area Business Cycle," CEPR Discussion Papers 3108, C.E.P.R. Discussion Papers.

Baffigi, A., R. Golinelli & G. Parigi (2004). "Bridge models to forecast the euro area GDP," International Journal of Forecasting, Elsevier, vol. 20(3), pages 447-460.

Banbura, M. & G. Rünstler (2007). "A look into the factor model black box - publication lags and the role of hard and soft data in forecasting GDP," Working Paper Series 751, European Central Bank.

Barhoumi, K., V. Brunhes-Lesage, O. Darné L. Ferrara, B. Pluyaud & B. Rouvreau (2008a). "Monthly forecasting of French GDP: A revised version of the OPTIM model," Documents de Travail 222, Banque de France.

Barhoumi, K. V. Brunhes-Lesage, O. Darné, L. Ferrara, B. Pluyaud & B. Rouvreau (2008b). OPTIM: a quarterly forecasting tool for French GDP, Banque de France Bulletin Digest – No. 174 – July-August 2008

Camacho, M., and Sancho, I. 2003. Spanish diffusion indexes. Spanish Economic Review 5: 173-203.

Diebold, F.X. and R.S. Mariano (1995) "Comparing Predictive Accuracy" Journal of Business & Economic Statistics, American Statistical Association, vol. 13(3), pages 253-63, July.

Diron, M. (2008). "Short-term forecasts of euro area real GDP growth: an assessment of real-time performance based on vintage data," Journal of Forecasting, John Wiley & Sons, Ltd., vol. 27(5), pages 371-390.

Forni, M., M. Hallin, M. Lippi, & L. Reichlin (2005). The generalized dynamic factor model: One-sided estimation and forecasting. Journal of the American Statistical Association 100, 830-840.

Gerhard Rünstler & F. Sédillot (2003). "Short-term estimates of euro area real GDP by means of monthly data," Working Paper Series 276, European Central Bank.

Golinelli, R. & G. Parigi (2005). "Short-Run Italian GDP Forecasting and Real-Time Data," CEPR Discussion Papers 5302, C.E.P.R. Discussion Papers.

Golinelli R. & G.Parigi (2007). "The use of monthly indicators to forecast quarterly GDP in the short run: an application to the G7 countries," Journal of Forecasting, John Wiley & Sons, Ltd., vol. 26(2), pages 77-94.

Gomez, V. & A. Maravall (1997) "Programs TRAMO and SEATS : Instructions for the user". Working Paper 97001, Ministerio de Economıa y Hacienda, Direction General de Analisis y Programacion Presupuestaria, Madrid.

Gomez, V. & A. Maravall (1998) "Automatic Modeling Methods for Univariate Series", Banco de España Working Papers 9808, Banco de España.

Harvey, D., S. Leybourne and P. Newbold (1997) "Testing the equality of prediction mean squared errors" International Journal of Forecasting, Elsevier, vol. 13(2), pages 281-291, June.

Hendry, D.F. & H-M. Krolzig (2001). Automatic Econometric Model Selection. London: Timberlake Consultants Press.

Hendry, D. y B. Nielsen, (2007). "Automatic Model Selection," Chapter Nineteen, in: Econometric Modeling: A Likelihood Approach, Princeton University Press.

Irac, D. & F. Sédillot (2002). "Short-Run Assessment of French Economic Activity Using OPTIM," Documents de Travail 88, Banque de France.

Pesaran, H. & A. Timmermann (2005) "Real-Time Econometrics," Econometric Theory, Cambridge University Press, vol. 21(01), pages 212-231, February.

Rünstler, G. & F. Sédillot (2003), "Short-term estimates of euro area real GDP by means of monthly data," Working Paper Series 276, European Central Bank.

Stock, J. H. & M. W. Watson (1998). "Diffusion Indexes," NBER Working Papers 6702, National Bureau of Economic Research, Inc.

Stock, J. H. & M. W. Watson (2002a). Forecasting using principal components from a large number of predictors. Journal of the American Statistical Association 97, 1167-1179.

Stock, J. H. & M. W. Watson (2002b). Macroeconomic forecasting using difusion indexes. Journal of Business & Economic Statistics 20 (2), 147-62.

U.S. Census Bureau (2007) "X-12-ARIMA Reference Manual: Version 0.3", Time Series Staff, Statistical Research Division, Washington.

Ziegler, C. & S. Eickmeier (2006). "How good are dynamic factor models at forecasting output and inflation? A meta-analytic approach," Discussion Paper Series 1: Economic Studies 2006,42, Deutsche Bundesbank, Research Centre.

Documentos de Trabajo Banco Central de Chile	Working Papers Central Bank of Chile
NÚMEROS ANTERIORES	PAST ISSUES

La serie de Documentos de Trabajo en versión PDF puede obtenerse gratis en la dirección electrónica: www.bcentral.cl/esp/estpub/estudios/dtbc. Existe la posibilidad de solicitar una copia impresa con un costo de $500 si es dentro de Chile y US$12 si es para fuera de Chile. Las solicitudes se pueden hacer por fax: (56-2) 6702231 o a través de correo electrónico: bcch@bcentral.cl.

Working Papers in PDF format can be downloaded free of charge from: www.bcentral.cl/eng/stdpub/studies/workingpaper. Printed versions can be ordered individually for US$12 per copy (for orders inside Chile the charge is Ch$500.) Orders can be placed by fax: (56-2) 6702231 or e-mail: bcch@bcentral.cl.

DTBC – 625 Mayo 2011
Introducing Financial Assets into Structural Models
Jorge Fornero

DTBC – 624 Mayo 2011
Procyclicality of Fiscal Policy in Emerging Countries: the Cycle is the Trend
Michel Strawczynski y Joseph Zeira

DTBC – 623 Mayo 2011
Taxes and the Labor Market
Tommaso Monacelli, Roberto Perotti y Antonella Trigari

DTBC – 622 Abril 2011
Valorización de Fondos mutuos monetarios y su impacto sobre la estabilidad financiera
Luis Antonio Ahumada, Nicolás Álvarez y Diego Saravia

DTBC – 621 Abril 2011
Sobre el nivel de Reservas Internacionales de Chile: Análisis a Partir de Enfoques Complementarios
Gabriela Contreras, Alejandro Jara, Eduardo Olaberría y Diego Saravia

DTBC – 620 Marzo 2011
Un Test Conjunto de Superioridad Predictiva para los Pronósticos de Inflación Chilena
Pablo Pincheira Brown

DTBC – 619 Marzo 2011
The Optimal Inflation Tax in the Presence of Imperfect Deposit – Currency Substitution
Eduardo Olaberría

DTBC – 618 Marzo 2011
El Índice de Cartera Vencida como Medida de Riesgo de Crédito: Análisis y Aplicación al caso de Chile
Andrés Sagner

DTBC – 617 Marzo 2011
Estimación del Premio por Riesgo en Chile
Francisca Lira y Claudia Sotz

DTBC – 616 Marzo 2011
Uso de la aproximación TIR/Duración en la estructura de tasas: resultados cuantitativos bajo Nelson – Siegel
Rodrigo Alfaro y Juan Sebastián Becerra

DTBC – 615 Marzo 2011
Chilean Export Performance: the Rol of Intensive and Extensive Margins
Matías Berthelom

DTBC – 614 Febrero 2011
Does Lineariry of the Dynamics of Inflation Gap and Unemployment Rate Matter?
Roque Montero

DTBC – 613 Febrero 2011
Modeling Copper Price: Regime Switching Approach
Javier García – Cicco y Roque Montero

DTBC – 612 Febrero 2011
Riding the Roller Coaster: Fiscal Policies of Non-renewable Resources Exporters in Latin America and the Caribbean.
Mauricio Villafuerte Pablo López-Murphy y Rolando Ossowski