

**SESSIONE VI**

**MODELLI DI PREVISIONE A BREVE E MEDIO TERMINE**

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**La previsione di breve termine delle principali variabili del mercato del lavoro**

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## Previsione di breve termine del mercato del lavoro

### ***Short-term Forecast of Labor Market Aggregates***

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#### **Sommario**

*In questo documento si presenta un modello per la previsione di breve periodo delle variabili del mercato del lavoro. Lo strumento si propone di fornire indicazioni sugli andamenti di breve termine del mercato del lavoro in Italia attraverso un utilizzo efficiente dell'informazione ad alta frequenza disponibile in corso d'anno. La valutazione di capacità previsiva, effettuata attraverso il confronto con un modello univariato, risulta soddisfacente.*

**Parole chiave:** Mercato del lavoro, bridge model, forecast evaluation

#### **Abstract**

*This paper presents a model for the short-term forecasting of the main aggregates of the Italian labor market. This is intended to provide a timely and reliable indications on the development of labor market variables and to allow for an efficient use of high frequency available information. Recursive 1-step-ahead forecast is evaluated in terms of RMSE and compared with a benchmark univariate model.*

**Keywords:** Labor market, bridge model, forecast evaluation

#### **Introduction**

This paper presents a model for the short-term forecasting of the main aggregates of the Italian labor market. This is intended to provide a timely and reliable suggestions on the development of labor market variables and to allow for an efficient use of high frequency available information. The target variables consist in both employed and unemployed figures provided by the quarterly Labor Force Survey (henceforth, LFS). Key indicators, as the unemployment rate and the labor force, are then predicted through identities.

The model contributes to Istat forecasting activity into two ways. First of all, the whole set of equations and identities may be considered as a separate block in the framework of Istat short-term forecasting model, which contributes to the forecasting of labor market aggregates consistent with quarterly GDP and demand components forecast. Secondly, the current structure of the model is arranged to mimic the labor market block in Istat annual macro-econometric model (MeMo-It), so to supplement the forecast of labor market variables for the first period of forecast.

The structure of the article is as follows: Section 2 describes the methodological approach; data are presented in Section 3; model specification is described in Section 4 while forecast evaluation is reported in Section 5. Section 6 discusses the main extensions of the model and concludes.

## I. Literature and empirical strategy

Several approaches have been followed in the empirical literature on labor market forecasting. It mainly focuses on the forecasting of the unemployment rate, as it is one of the key variables to address economic policy measures. Forecasting the unemployment rate is an important and difficult task for policymakers, especially surrounding economic downturns. Several approaches have been proposed in the literature.

The first is based on the historical time-series properties of the unemployment rate and short-term indicators of the labor market. There is a growing body of research which points to the fact that the unemployment rate in the U.S. (Hansen, 1997; Verbrugge, 1997; Koop and Potter, 1999; Altissimo and Violante, 2001) and Europe (Brannas and Ohlsson, 1999; Skalin and Terasvirta, 2002) exhibits asymmetric behavior in the sense that it increases more quickly than it decreases. Various explanations of this non-linear behavior have been offered in the literature. For example, Aolfatto (1997) uses Pissarides (1985) simple search and matching model to explain cyclical asymmetry in unemployment rate fluctuations in the U.S. He finds that the asymmetry comes from an adverse productivity shock, which brings about the destruction of certain jobs in the economy that are not recreated as aggregate economic conditions improve, forcing individuals to seek out new job opportunities. Greenwood, MacDonald, and Zhang (1996) and Mortensen and Pissarides (1994) also use various search and matching models to explain the performance of the unemployment rate in the U.S. A related literature has pointed to asymmetries in Okun's Law where changes in output can cause asymmetric changes in the unemployment rate (Lee, 2000; Crespo-Cuaresma, 2003). Finally, several papers relate nonlinearities to hysteresis (Proietti, 2003). According to Skalin and Terasvirta (2002), this non-linear behavior is consistent with large, linear responses to economic shocks, followed by slow, non-linear movements towards equilibrium. They propose a simple univariate LSTAR model as a useful way of summarizing the main features of the asymmetric behavior of the unemployment rate.

The second approach is based on the relationship between output growth and unemployment changes and is known as Okun's law (Okun, 1962). This approach assumes that shifts in aggregate demand cause output to fluctuate around potential. These output movements cause firms to hire and fire workers, changing employment; in turn, changes in employment move the unemployment rate in the opposite direction. It is costly to adjust employment, so firms accommodate short-run output fluctuations by adjusting the number of hours per worker and/or the intensity of workers' effort (which produces procyclical movements in measured productivity). Because of these other margins, the response of employment to output is less than one-for-one with employment. Increases in employment raise the returns to job search, so to induce workers to enter the labor force. Procyclical movements in the labor force partly offset the effects of employment on the unemployment rate.

Okun's Law is usually estimated following two approaches. The first is to estimate the "levels" equation. In this case, the problem is to measure the natural rate  $U_t^*$  and potential output  $Y_t^*$ . The other strategy is to estimate the "deviation" version of the equation. But this latter approach suffer from endpoint problem revisions. Indeed, another approach to testing Okun's Law consists in measuring short-run fluctuations in  $U_t$  and  $Y_t$  with forecast errors. Specifically, Ball et al. (2013) examine deviations of four-quarter changes in output and unemployment from forecasts published by the Survey of Professional Forecasters. They assume that forecast errors reflect unanticipated shifts in aggregate demand, which should move unemployment and output in the proportion given by Okun's Law.

A further approach, popularized by Elsby et al. (2012), consists in specify models of labor force flows (instead of stocks). Here, variation in unemployment may occur as a result of variation in the rate at which workers flow into the unemployment pool, variation in

the rate at which unemployed workers exit the unemployment pool, or a combination of the two. The relative contributions of changes in inflow and outflow rates to changes in unemployment have been largely documented for the U.S. Elsby et al. (2012) develop a method that exploits additional data on unemployment at higher durations to construct a set of comparable time series for the unemployment inflow and outflow rates across countries. Their measures allow to document a set of stylized facts on unemployment flows among OECD economies. Another application, which is built on the decomposition of labor market flows, is in Barnichon and Nekarda (2012).

The approach proposed in the paper takes some of the features of the above literature. The core of forecasting model consist of two stochastic equations: the one for employed is specified as a function of GDP. This allows the forecasting of labor market aggregates to be consistent with quarterly GDP forecast. The other for unemployed persons basically includes survey expectations as covariates. A further extension of this model is to consider occupied persons as an additional covariate.<sup>1</sup>

Relating to the empirical approach, our exercise lies in the traditional framework of single multivariate linear equations. It is usually referred as “Bridge Model” in the empirical forecasting literature and is largely adopted for the short-term prediction of GDP and demand components (see, for example, Parigi and Schlitzer, 1995), such that the development of the variables of interest is forecast through high frequency and timely indicators, pre-selected and significantly related to the target aggregates.

Although the model does not include “true” behavioural equations, thus implying causal relationships between the variables, the selection of indicators is carried out by the researcher in accordance with the relationships suggested by the economic theory. The model consists of stochastic equations to predict both the stock of employed and of the unemployed. Labor supply and unemployment rate forecast are obtained through accounting identities. Other than its implementation, an advantage of this approach is to predict the components of the labor force, thus entailing an indirect approach for the forecast of unemployment rate. This procedure can be considered as a way to tackle the asymmetric nature of unemployment movements - in particular, the fact that increases tend to be steeper than decreases - a feature which led to prefer non-linear specifications of time series models for unemployment rate out-of-sample forecast (Stock and Watson, 1999).

## II. Data

The availability of timely and reliable information is a the key element in economic policy decision making and prediction activity. The dataset used in this paper consists into two sets of data.

The first group includes the time series of the aggregates of interest: employed persons, unemployed persons, labor force, unemployment rate. Those figures are available at a quarterly frequency, but on a monthly basis since 2004, which is the beginning of the continuous LFS, which replaced the old survey. The official release of quarterly time series is back to the fourth quarter of 1992, and also to 1977, although this latter reconstruction is limited to the main labor market aggregates. Time series data availability has played a decisive role in the building of the model. It is important to highlight that the LFS reconstruction is only available for not seasonally adjusted time series. As a result, the forecasting

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<sup>1</sup> We can derive Okun’s Law from the underlying relationships between employment and output, and between unemployment and employment.

exercise is performed using raw data also for the selected sample of indicators.

The series of indicators are selected considering both their timeliness and reliability; in spite of a wide information on the short-term evolution of labor market, the set of time series selected for the purposes of empirical analysis is restricted to few indicators. They consist of both quantitative variables, such as standard labor units and GDP (drawn from national accounts) and of monthly and quarterly information derived from business and consumer surveys, such as employment expectations, level of hours worked, labor input shortage (obstacles to production in the manufacturing sector), liquidity expectations, households' price assessment and households' unemployment expectations. Target variables and indicators are reported in Table 1.

### III. Model specification

The current version of the model provides 1-quarter ahead forecast for the following variables:

- Employed
- Unemployed
- Labor Force
- Unemployment Rate

Employed and unemployed persons are predicted by means of two stochastic equations (respectively, OCC and U); the labor force and the unemployment rate are obtained using definitional identities.

The structure of the model is as follows:

$$1) \text{ OCC}_t = f(\text{GDP}, \text{occe}, \text{prodex})$$

$$2) \text{ U}_t = f(\phi(L)\text{U}, \text{occe}, \text{price}, \text{liqex})$$

$$3) \text{ LS}_t \equiv \text{OCC}_t + \text{U}_t$$

$$4) \text{ UR}_t \equiv \left( \frac{\text{U}}{\text{LS}} \right)_t$$

$$5) \text{ LU}_t = f(\text{OCC}, \text{hr})$$

where equation for the employed (OCC) includes an output indicator (GDP), employment expectations (OCCEX) and production beliefs (PRODEX) as indicators; the equation for the stock of unemployed persons (U) is specified as a function of its lagged values and some business survey variables: firms's expectations on employment (OCCEX), liquidity conditions (LIQUEX) and consumer's assessment on the past dynamic of consumer prices.

Dependent variables in 1) and 2) are double differenced both to remove seasonal factors ( $\Delta_4$ , where  $\Delta=(1-L^4)$  and L the lag operator) and also because LFS are in form of stocks and an additional difference is applied to get stationarity. Business survey indicators are differenced only once. We do not explicitly formulate any assumption of long run co-movements between the variables. The specifications are the result of a reduction process starting from a general model (General Unrestricted Model) which parameters are sequentially reduced until the null of diagnostic testing is rejected (normality, serial correlation, heteroskedasticity, structural breaks), and provided that no significant loss of information occurs with respect to the general model (Hendry and Krolzig, 2005).

An additional equation can be added to the structure of the model. It refers to standard labor units (LU), which prediction can be obtained in terms of the stock of persons employed and the assessment of hours worked; it is currently part of the structure of the model.

#### **IV. Forecast evaluation**

The performance of the model is evaluated through an in-sample 1-step-ahead forecasting exercise. The model is estimated over the period 1994Q1-2006Q2, while its predictive ability is evaluated through recursive forecast over the period 2006Q3-2012Q3. The assessment is made in terms of relative root mean squared error (relative RMSE), which is obtained with respect to a benchmark AR(1) model. The results are presented in Table 2 which includes, as additional measures, the mean error (ME) and the mean absolute error (MAE). The metric of such measures is expressed in terms of annual changes for the employed, unemployed and labor supply; in terms of percentages points for the unemployment rate. Plots of the 1-step-ahead forecast vis-à-vis the actual values are displayed in Figure 1. The prediction error of the nowcast (in terms of RMSE) is particularly low for the employed (0.5 percentage points), significantly higher for unemployed (4.6 percentage points). The forecast for the employed and unemployed are used in the identity for labor supply and the unemployment rate. The prediction error, particularly low for the labor supply (1.4 percentage points) indicates that the prediction errors of the corresponding components are partly compensated. This represents the aggregate with the worse forecasting accuracy (in terms of relative RMSE).

The accuracy of nowcast for the unemployment rate (obtained as the ratio of predictions for unemployed and labor force) is satisfactory and equals to about 0.3 percentage points (in terms of RMSE). Moreover, the forecasting performance of the model outperform that of the standard benchmark, particularly in the case of unemployed (the relative RMSE is 0.62) and of the unemployment rate (relative RMSE is 0.53).

These findings confirm the effectiveness of our approach. It refers to the theoretical results (and the corresponding empirical evidence) of the literature on combining forecasts (i.e., Bates and Granger, 1969). In particular, Hendry and Clements (2002) have shown that the average of predictions from different models is often associated with a predictive ability which is superior to the single best model, because averaging predictions attenuates the effects due to potential miss-specification of the single models.

Such evidence may be considered, on the whole, successful if we consider the characteristics of the time interval we have considered. Indeed, it spans two long recessive phases, each with specific causes. The first recession was caused by an exogenous shock, the second was mainly due to economic/institutional factors endogenous to the Italian economy. Also the evolution of the labor market is peculiar, as it showed a stability of employment levels during the first recession while an exceptional increase in labor supply occurred in the second.

Concerning model's equations, it is relevant to consider that the equation for em-

ployed has correctly predicted the trend in employment in the period between the beginning of the first recession (2008-2009) and the third quarter of 2010 (with the exception of the second quarter of the same year; Figure 1 panel a). The development in 2012 is underestimated: despite the weakening in economic activity, employment showed an overall resilience due to the phenomenon of labor hoarding.

The equation for unemployed shows higher forecast errors, especially in the period of the first recession (Figure 1 panel b). This performance may be explained considering that the fall in economic activity observed in this time span was mainly triggered by exogenous factors, related to the international financial crisis. The improvement in second part of the sample (from 2011Q2 onwards) is achieved in spite of exceptional growth in participation to the labor market: the increase in unemployment (in particular, for the younger cohorts of the active population) was a result of the decline in employment and of the increase in labor supply. This may be considered as an unusual pattern of labor market participation, presumably due to the so called “added worker effect”<sup>2</sup> so that, in a depressed labor market, individuals could start searching work or increase the effort in searching a work in order to maintain their consumption levels.

### **Conclusions and further developments**

The main extensions of the model can be listed as follows: 1) to complement the current structure of the model with an equation for wages per capita, in order to obtain a short-term forecasts for the corresponding variables in the "labor market" block of MeMo-It model; 2) specify models at a monthly frequency for the direct prediction of employed, unemployed and unemployment rate (Bardsen and Hurn, 2012; Proietti, 2003; Skalin and Teräsvirta, 2002). The 1-step ahead prediction for each aggregate is then obtained as a combination of forecasts from quarterly model and monthly models; these allow to more efficiently account for the monthly information available in the period of interest; 3) To cast the actual models in the framework of mixed frequency models (Ghysels et al., 2006; Mariano and Murosawa, 2003); 4) extend the forecast horizon up to 4-steps-ahead.

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<sup>2</sup> Economic models of family utility maximization predict that to compensate the income losses due to their partners' job loss, wives (second earners) may choose to increase their labor supply, i.e., inactive wives may newly enter the labor market and become so-called ‘added workers’ and already participating wives may choose to enter in the labor market exerting more search effort.

## References

- Altissimo F. & G. L. Violante, 2001. "The non-linear dynamics of output and unemployment in the U.S," *Journal of Applied Econometrics*, John Wiley & Sons, Ltd., John Wiley & Sons, Ltd., vol. 16(4), pages 461-486.
- Aolfatto, D. (1997): "Evidence and theory on the cyclical asymmetry in unemployment rate fluctuations" *The Canadian Journal of Economics*, 30, 709–721.
- Bacchini, F. et al, (2013), "Building the core of the Istat system of models for forecasting the Italian economy: MeMo-It" *Rivista di statistica ufficiale, ISTAT - Italian National Institute of Statistics - (Rome)*, vol, 15(1), pages 17-45,
- Ball, M.L., Leigh, D. and P. Loungani (2013), "Okun's Law: fit at fifty?" NBER WP No. 18668.
- Bardsen G, e S, Hurn (2012), "Asymmetric Unemployment Rate Dynamics in Australia", *SNDE*,
- Barnichon R, e C, J, Nekarda (2012) "The ins and outs of forecasting unemployment: using labor force flows to forecast the labor market", *Brookings Papers on Economic Activity*, Issue 2 pp, 83-131,
- Bates, J. M., e C. W. J. Granger, (1969), "The combination of forecasts", *Operations Research Quarterly*, 20, 451-468. Reprinted in T.C. Mills (ed.), *Economic Forecasting*. Edward Elgar, 1999.
- Brannas, K. and H. Ohlsson (1999): "Asymmetric time series and temporal aggregation," *Review of Economics and Statistics*, 81, 341–344.
- Crespo-Cuaresma, J. (2003): "Okun's law revisited," *Oxford Bulletin of Economics and Statistics*, 65, 439–451.
- Elsby, W.L.M., Hobijn,B. and A.Sahin (2012), "Unemployment dynamics in OECD", *ReStat*.
- Ghysels E, Sinko A. and R. Valkanov (2006). "MIDAS regressions: Further results and new directions.", *Econometric Reviews*, 26, 53 90.
- Golinelli R, e G., Parigi (2004), "Using monthly indicators to bridge-forecast quarterly GDP for the G7 countries", mimeo,
- Greenwood J. & G. M. MacDonald & G.-J. Zhang, 1995. "The cyclical behavior of job creation and job destruction: A sectoral model," *Economic Theory*, Springer, Springer, vol.7(1), pages 95-112.
- Hansen, B. E. (1997): "Inference in TAR models," *Studies in Nonlinear Dynamics and Econometrics*, 2, 1–14. (verifica che è questo).
- Hendry, D. F. e M. P. Clements (2002), "Pooling of forecasts", *Econometrics Journal*, Vol. 5, pp. 1-26.
- Hendry D.F.and Krolzig H.-M., 2005. "The Properties of Automatic "GETS" Modelling," *Economic Journal*, Royal Economic Society.
- Koop, G. and S. M. Potter (1999): "Dynamic asymmetries in U.S. unemployment," *Journal of Business and Economic Statistics*, 17, 298–312.
- Lee, J. (2000): "The robustness of Okun's law: evidence from OECD countries," *Journal of Macroeconomics*, 22, 331–356.
- Mortensen, D. and C. Pissarides (1994): "Job creation and job destruction in the theory of unemployment," *The Review of Economic Studies*, 61, 397–415.
- Parigi G, e G, Schlitzer (1996), "Una nota sull'uso di indicatori anticipatori nei modelli econometrici per la previsione a breve termine", *Rivista di politica economica*, 86(9), pp, 45-66.
- Peel, D. A. and A. E. H. Speight, 1998. "The nonlinear time series properties of unemployment rates: some further evidence," *Applied Economics*, Taylor & Francis Journals, vol. 30(2), pages 287-294, February.
- Okun, A. M. (1962), "Potential GNP: Its Measurement and Significance." Reprinted as Cowles Foundation Paper 190.
- Parigi, G. and G. Schlitzer (1995), "Quarterly forecasts of the italian business cycle by means of monthly economic indicators", *Journal of Forecasting Volume 14*, Issue 2, pages 117–141.
- Pissarides, C. (1985): "Short-run equilibrium dynamics of unemployment, vacancies, and real wages," *American Economic Review*, 75, 676–690.
- Proietti, T, (2003), "Forecasting the U,S, unemployment rate" *Computational Statistics and Data Analysis*, 42, 451–476,
- Rothman, P. (1998): "Forecasting asymmetric unemployment rates," *Review of Economics and Statistics*, 80, 164–168.
- Skalin, J, e T, Teräsvirta, (2002), "Modelling Asymmetries and Moving Equilibria in Unemployment Rates" *Macroeconomic Dynamics*.
- Stock, J. H., and M. W. Watson (1999), "Cointegration, Causality, and Forecasting: A Festschrift in Honor of Clive W. J. Granger.", ed. Robert Engle and Halbert White, Chapter A Comparison of Linear and Nonlinear Univariate Models for Forecasting Macroeconomic Time Series. Oxford University Press.
- Verbrugge (1997): "Investigating cyclical asymmetries," *Studies in Nonlinear Dynamics and Econometrics*, 2, 15–22.

**Table 1. – Target variables and indicators**

<b>Indicator</b>	<b>Acronym</b>	<b>Frequency</b>	<b>Source</b>
Employed	<i>OCC</i>	Quarterly	LFS (Istat)
Unemployed	<i>U</i>	Quarterly	LFS (Istat)
Standard Labor Unit	<i>LU</i>	Quarterly	Quarterly National Accounts
GDP (chained linked values)	<i>GDP</i>	Quarterly	Quarterly National Accounts
Employment expectations	<i>occes</i>	Monthly	Business surveys
Assessment on hours worked	<i>h_ind</i>	Quarterly	Business surveys
Labor shortage	<i>scars</i>	Quarterly	Business surveys
Price assessment	<i>price_p</i>	Monthly	Consumer surveys
Liquidity expectations	<i>liqex</i>	Monthly	Business surveys
Unemployment expectations	<i>unexp</i>	Monthly	Consumer surveys

**Table 2. – Forecast evaluation – 1-step-ahead forecast (2006Q3 – 2012Q3)**

Variables*	ME	MAE	RMSE	RMSE(*)	Relative RMSE
Employed (y/y)	-0.00001	0.00367	0.00468	0.005983	0.78238
Unemployed (y/y)	-0.01223	0.03589	0.04581	0.07414	0.61784
Labor supply (y/y)	0.00121	0.00852	0.01101	0.01391	0.79152
Unemployment rate (%)	-0.07815	0.25053	0.31033	0.57838	0.52916

(\*) All variables are reported in annual changes except the unemployment rate, measured in percentage points.

**Figure 1 – Employed, unemployed and unemployment rate – 1-step-ahead forecast**