Analysis of Spanish Wholesale Gas Price Determinants and Non-stationarity Effects for Modelling

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Abstract This study expands on previous research on Spanish gas prices by investigating on the nature of the existing relationships with its main determinants and with special attention to Brent oil price relationship. The study focus on capturing the best representation of the main drivers behind SGP movements as a sensible step towards a more complex modelling exercise to explain Spanish gas pricing mechanics. In addition the analysis does also seek to better understand long-term persistence properties of SGP to obtain a view of how and to what extent those are transmitted through links with other primary energy commodities. Results from our investigation show that when comparing the different lags of Brent oil prices fitting normalized gas prices, the proxy best representing crude oil price is close to a Brent price lagging six months with validity for the next three months. Results for generic unit root tests indicate that all the series analysed are stationary in first differences logarithm what would open scope for using cointegration methods to study SGP long-run dynamics in the future.

Keywords: Spanish gas prices, gas market, crude oil, oil products, stationarity.

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1 Introduction

In competitive markets, with multiple sellers and buyers, prices are mostly driven by supply and demand with price itself providing signals to ensure market equilibrium. In this sense and based on our findings in previous research, this study aims primarily to better understand predictability of Spanish gas prices (SGP) mainly in relation with the factors that contribute to it and also analyse long-term stationarity properties associated with those main factors. The intention of the study will ultimately be to serve as reference for further work on SGP modelling and forecasting as important tools to effective and efficient planning.

2 Data and stationary tests

The selected time scope expands from 2002 to 2013, coinciding with a critical period in the Spanish gas market that continues to undertake additional efforts to attract open gas market competition and at the same time consolidate a reliable and modern gas supply base. In order to perform the study, we have examined the main information publicly available in Spain for wholesale gas prices of which perhaps the most relevant today is that collected by the regulatory body the CNMC[4]. It has to be said that, given the importance of imported LNG spot at the margin, we have also considered the NBP[5] benchmark as the relevant indicator of global gas price effects. Figure 1 shows time variations of monthly crude oil spot, SGP and NBP prices over the study period.

[4] Comisión Nacional de los Mercados y Competencia (CNMC).

[5] NBP, i.e. National Balancing Point

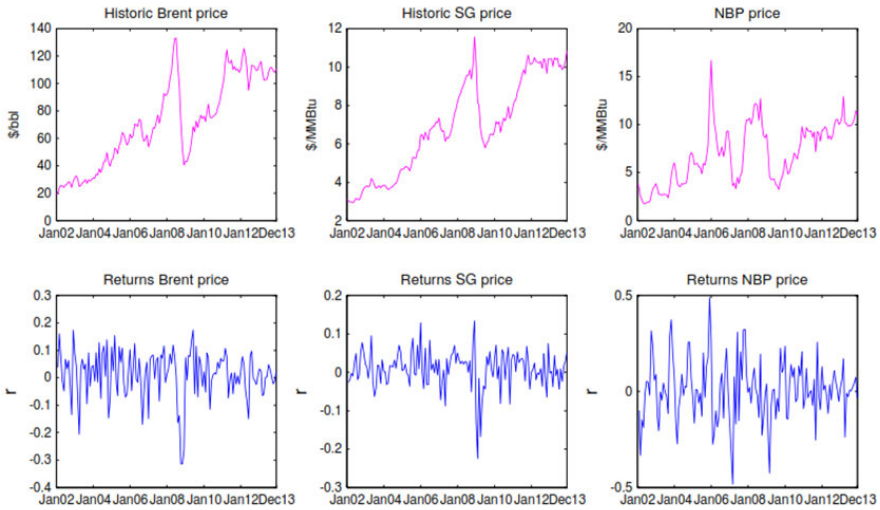

Fig 1 *Evolution of Brent, Spanish Gas and NBP prices. Source: CNMC*

As it can be seen on the graph crude oil and gas data sets share large swings in common taking into account the lagging effect of oil indexation and the smoothing effect of rolling average used in the gas price formula. Conversely shocks affecting NBP prices over the sample period are not necessarily similar, for example at the beginning of 2006 with soaring NBP prices. It is interesting to realize that in spite of a well-connected LNG market worldwide, Spanish gas prices show very limited response to other than crude oil-related fundamentals.

To test the stationarity or non-stationarity of the price series we have considered ADF and KPSS[6] tests on logprices in levels and first differences. It has to be noted that throughout all the testing process we have included a linear time trend as an option to allow for a plausible description of the data under both the null and alternative hypotheses in all cases. In order to specify number of lagged difference terms, i.e. lag length to be added to the test regression (0 yields the standard DF test; integers greater than 0 correspond to ADF tests) we use information criteria AIC[7] . Usual Ljung-Box Q-test to assess serial autocorrelation at the selected lags probe that in all cases number of lags are sufficient to remove serial correlation in the residuals.

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[6] We refer to the Augmented Dickey Fuller (ADF) and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests.

[7] Akaike Information Criterion The most suitable model has the lowest value of the Akaike information criterion.

Table 2 summarizes the results of various tests performed including a trend to account for the alternative that the series is stationary rejecting the unit-root null in favour of the alternative (ADF test) or accounting for a stationary null versus the unit-root alternative (KPSS test).

Table 2 *Standard unit Root Tests*

	Log price in levels				*Log price 1st differences*			
	Without trend		*With trend*		*Without trend*		*With trend*	
	ADF	*KPSS*	*ADF*	*KPSS*	*ADF*	*KPSS*	*ADF*	*KPSS*
SGP	1.789	12.214	-1.807	1.504	-10.119	0.099	-10.355	0.060
B613	1.783	12.168	-1.891	1.557	-5.404	0.297	-5.887	0.122
GO601	0.863	11.370	-2.081	1.899	-3.062	0.753	-3.541	0.140
LSFO601	1.116	12.941	-3.260	0.713	-3.536	0.218	-3.891	0.108
NBP	0.083	6.780	-3.314	0.879	-7.214	0.044	-7.204	0.046
Coal	0.603	7.557	-1.659	1.370	-10.028	0.160	-10.058	0.053
cValue	-1.944	0.463	-3.443	0.146	-1.944	0.463	-3.443	0.146

Tests results clearly indicate that none of the six variables employed in this empirical investigation is stationary at any conventional level. The ADF test does not reject the null hypothesis of a unit root for the levels of the six prices. The KPSS test, in which the null hypothesis is stationarity, indicates that the null hypothesis is clearly rejected for the level forms of all series. When the tests are applied to the first-differences of the variables, the results strongly implies that all variables are stationary, being integrated of order one I (1).

3 Determining fundamental factors

In order to consistently support our research, a closer look into the main factors that most influence imported gas prices in Spain, i.e. with cause-effect implications, is needed. Based on previous research and experience, we have selected a number of potential 'best' explanatory variables which main connection with SGP comes through the direct links with base gas prices in the individual contract price formula that in turn shapes resulting SGP monthly prices analyzed. It has to be noted that in spite of their relevant connection with gas prices through the indexation formula, Consumer price index (IPC) and US/Euro exchange-rate levels have not been included since they both are determined by a multitude of other non-energy factors and therefore would be distorting the main objective of our investigation (Figure 4 shows IPC evolution as an example of this issue).

2.1 Brent Crude Oil price (US dollars per barrel)

Brent crude oil price can be considered the main exogenous factor explaining gas prices mainly because its direct links through the formula calculation. Consequently one the key issues along the study will be to analyze in what manner, i.e. which lags to include in the model[8]. From experience on gas supply contracting but also based on the characteristics of oil indexed swing options in Europe, we know that some formulas are more popular than others[9]. In Figure 2 we compare the different lags to start calibrating the regression model. Gas prices are normalized values in respect of Brent oil prices and not in $/MMBtu to better notice how the different rolling Brent lines fit with the red SGP line.

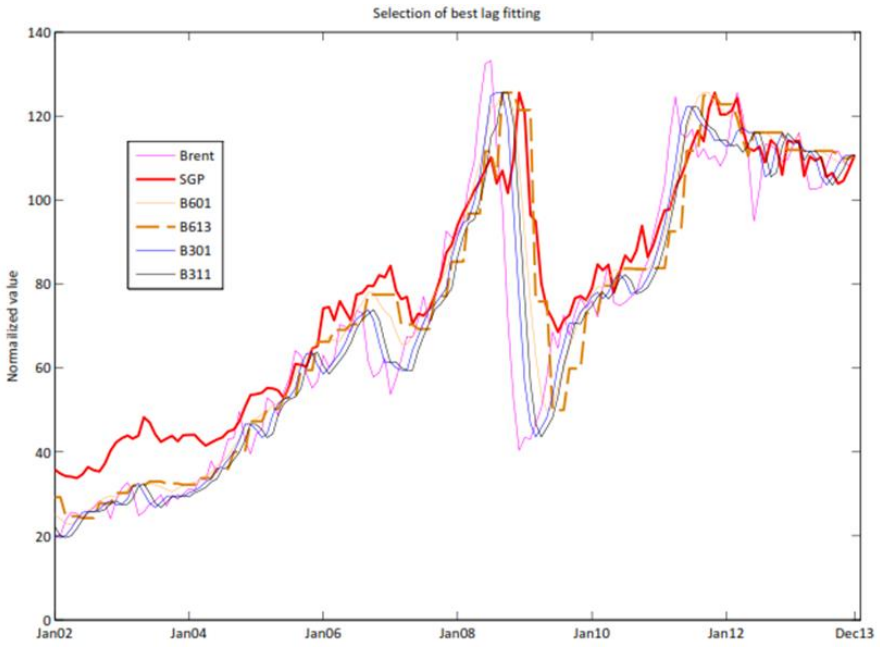

Fig 2 *Selection of price lags*

[8] Predictors in dynamic regression models may include lagged values of exogenous explanatory variables (distributed lag, or DL, terms), lagged values of endogenous response variables (autoregressive, or AR, terms), or both.

[9] Oil price formulas consist of three parameters: the number of averaging months resulting in a gas price that is the average of past oil prices within a certain number of months, the time lag that determines the time lag between the months the average is taken of and the months the price is valid for and finally the number of validity months setting the number of months for which the price is valid.

Not surprisingly it can be noticed that B613 is the Brent series that would correlate best with SGP. As a matter of fact we found correlation of 0.98 between SGP and B601or B613 to be higher than with the rest.

2.2 Gasoil and Low Sulphur Fuel Oil (US dollars per ton)

Arising as a result of the main pricing principle dominating Europe, a substantial part of Spanish long-term contracts are also indexed to oil products in addition to Brent oil price. Although some older contacts included HSFO[10] as index, after be banned by the EU this index has been replaced. As with Brent oil indexed contracts, oil products indexation intents to find a reference price through changes in the prices of fuels assumed to be closest competitors of gas.
After deciding on Brent oil lags and for consistency we will consider GO601 and LSFO601 as initial parameters for our regression exercise expecting that both will improve SGP predictions and model fit. Using in this case a moving average instead of a step function will simplify calculations with no effects on the results. Figure 4 shows the remarkable fit of GO601 and LSFO601 to SGP.

2.3 Coal (US dollars per ton)

Although we will not get deeply involved in coal-gas interaction dynamics, clearly the most visible link between gas and coal prices is found when analyzing operations at the electricity market by gas and coal-fired power generation plants. In this respect, for a CCGT the decision to generate electricity or not, will depend on the 'spark spread', i.e. the difference between the cost of gas generating an extra MWh of electricity and the revenue obtained from the sale of electricity at the System Marginal Price (SMP) competing directly against the similar 'dark spread' for coal plants. Figure 4 shows the normalized prices of coal and SGP since 2002 reflecting periods of relative competitive advantage between the two.

2.4 National Balancing Point (NBP) (US dollars per MMBtu)

The spot market for LNG in Spain may still be small relative to the contract market, but it is important when traders set prices at the margin. We consider that the NBP market, the most liquid in Europe, is a significant yardstick regarding the potential for hub pricing influences in SGP, especially with reference to LNG spot

[10] High Sulphur Fuel-oil

trade. Moreover other liquid hubs that could have been considered in the analysis, e.g. TTF or Zeebrugge are highly correlated with NBP and therefore will not add substantial inside into the study. Figure 4 shows the different dynamics of NBP and SGP in spite of potential for similar long term mean reversion patterns.

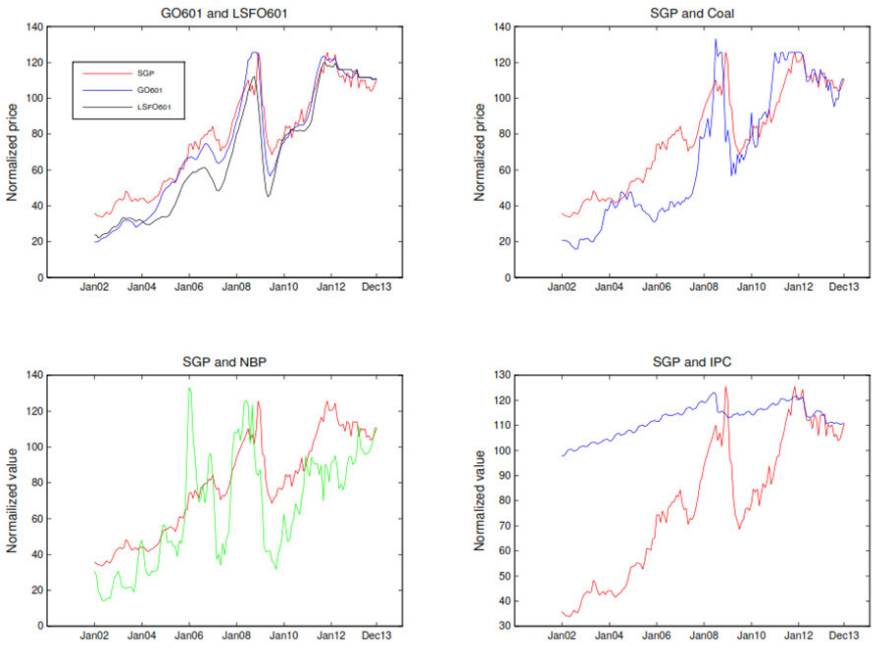

Fig 4 *All factors vs. SGP. Source International markets database.*

Table below shows a summary of variables and acronyms considered in the study.

Table 1 *List of variables used in the analysis affecting Spanish wholesale prices*

	Factor		Units
Response variable	SGP	Monthly Spanish Wholesale gas price	$/MMBtu
Explanatory variables	**Oil and oil products**		
	B613	Average price of previous 6 months valid for next three months	$/ton
	G601	Average NWE Gasoil FOB 0.2% S price of previous 6 months for current month	$/ton
	LSFO601	Average NWE LSFO FOB 0.1% S price of previous 6 months for current month	$/ton
	Gas market		
	NBP	Monthly average spot NBP	$/MMBtu
	Other markets		
	Coal	Monthly average McCloskey ARA Coal price	$/ton

4 Conclusion

Based on previous research we examined the relationship between SGP and a set of factors to be selected as potential 'best' indices to be further utilised for modelling and prediction of imported gas prices in Spain either through multiple OLS analysis or through cointegration based techniques. As a result of the pre-screening process we found that Brent oil price, Gasoil and Low Sulphur Fuel-oil price (all lagged 6 months) NBP and Coal are predictors that could contribute best. These results are not surprising given the nature of indexation of tipical long-term natural gas formulae. It is interesting however to find that a lag of six months in all oil and oil products benchmark is the most relevant on average.

Furhermore we found that the range of predictors selected are nonstationary, that is, the values of the time series do not fluctuate around a constant mean or with a constant variance what anticipates promissing results from a more complex cointegration analysis. As it is well known regressing nonstationary time series can lead to spurious regressions and as a matter of fact high correlation coefficients and high residual autocorrelation can be signs of spurious regression. Possibly and although regression might appear to give reasonable short-term forecasts, it will not be consistent for long-term based predictions. Moreover the the fact that typically time series data are not independent and effects of previous events have an important role on predictions, leads us to believe that advanced dynamic regression techniques will be most relevant for future modelling work.

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