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Exchange Rates And Retail Prices

To what extent has the strong Euro/U.S. Dollar exchange rate affected the consumer diesel prices through pass-through effects?

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ABSTRACT

In this paper we want to investigate the existence of an exchange rate pass through and the relationship between consumer prices for diesel and its made determinants: price of crude oil; interest rates; harmonized consumer price indices for the euro area and Austria as well as the exchange rate between the Euro and U.S. Dollar. In addition it was tried to find a cointegrating relationship between diesel prices in Austria and the exchange rate.

Economic theory suggests that a relationship between these macroeconomic variables exist. It seems to be trivial economic knowledge that the oil price through the exchange rate influences the diesel price for consumers in Austria. The relationship was verified when including the harmonized consumer price index for the euro area. Despite our first expectations the influence of interest rates on the Austrian diesel prices is statistically insignificant. Further tests rejected a cointegrated relationship between the exchange rate and diesel prices. Yet the Granger causality showed an influence of the exchange rate on the retail diesel price.

CONTENTS

INTRODUCTION

> "Crude-oil futures rose […] with prices likely to move in a relatively narrower range this week amid progress in resolving Greece's debt crisis, which could reduce volatility for both the euro-dollar exchange rate and crude."[1]

With drivers both sides the Atlantic (and the Pacific, for that matter) marveling at the furious post-recession recovery of oil prices, outshining even the most impressive of GDP growth figures, the subject is certainly one of the more fascinating ones out there. The scores of intersecting, intertwined, inter- and independent factors affecting the 'mother of commodities' have accounted for an even higher amount of debate and speculation, policy and position papers, journal and newspaper articles. This attempt is not guided by the desire to explain the inherent nature of oil price fluctuations, or the need to predict if, where and when new heights will be reached. Rather, we focus on relative factors, in this case on the currency in which the resource is denominated (U.S. Dollars), and the according implication for countries (in this case Austria, specifically) that use a different currency. In accordance with seminal exchange rate pass-through literature and the corresponding methodological framework, we set out to examine the extent to which Dollar/Euro exchange rate fluctuations have affected Austrian retail diesel prices since the advent of the European Monetary Union. The literature provides an abundance of exchange rate pass-through examinations, yet we could not find one that mirrors our own interests. Now nearing the definitive end of the 'Great Recession', and with the topic of currency wars having gathered a substantial deal of attention in months past, some sovereigns could be tempted to devalue their legal tender to spur exports and alleviate their indebted balance sheets – a prospect that would work for a handful, but could result in effective chaos should too many attempt to enact the same policy.

Since it became the area's 'real', graspable currency in 2002, the Euro has been on a trended, if sometimes shaky, rise vis-à-vis the Dollar. The most straightforward economic interpretation of such a process is that Euro goods become less competitive in America, leading to a general fall, or growth slowdown, of Euro exports. Coincidentally, Dollar denominated goods are expected to be more attractive in Europe, leading to a rise, or speedier growth, of imports from across the Atlantic. Since oil is such a Dollar denominated good, we should expect to see a more muted rise in the Diesel price than we would have seen without the currency appreciation. Our investigation pursues whether the real changes in the exchange rate, and the according relative increase in Euro purchasing power, were passed on to consumers at the retail level.

Our investigation is set up to encompass the necessary range of methods for a meaningful analysis. We start out by setting up the theoretical frame work. This is important to discuss the results. The theory should give a lead way to the possible implications of the results. Also, as our premise is to have a real-life value, we want to show that the results of the empirical study correspond with the theory. Next, we discuss the data, its origin, as well the summary statistics. This should give a first insight into the data and the way it behaves. Following this, we discuss the econometric models as well as the estimation methods used. We talk about the models estimated and why these where chosen. Finally we present the results and conclusions where we present our favored estimation. Our conclusion is a small analysis of the situation as it is and the implications that the results confer.

[1] From FUTURES: Crude Rises Amid Progress on Greece By Cheang Chee Yew of DOW JONES NEWSWIRES JULY 4, 2011, 3:05 A.M. ET.OIL http://online.wsj.com/article/BT-CO-20110704-701238.html

THEORETICAL FRAMEWORK

The consumer prices of diesel are subject to a certain amount of daily fluctuation, yet several determinants of the consumer price are fixed in the short run. How can this be? We can assume that ongoing taxation on fuels is constant and the production costs in refineries are also fixed, for there is no foreseeable change in production technology that would produce significant cost savings. Hence we are fairly certain that this assumption holds. So, the starting point of our investigation is that the price volatility is mainly attributable to the daily fluctuations of oil prices on the main European oil market in Rotterdam. As oil is traded in U.S. Dollars, the exchange rate between the Euro and U.S. Dollar is consequently an important factor in the price making process. As the oil market is a typical spot market it attracts speculation. Due to this, it seems logical that an interest rate would also affect the consumer price. To acknowledge this possible effect we have used a Euro area wide interest rate.

The critical pint and focus of this investigation is the different denominations of oil and diesel. The exchange rate acts through the pass-through effect, so external shocks to domestic prices are passed on more or less depending on the exchange rate value. To this end, first, some theories that provide insights into the pass-through of shocks on prices in general, are briefly explained. As an important part of our analysis refers to the pass-through of exchange rate shocks, a further part of this section shortly reviews important aspects of this literature.

According to Goldberg and Knetter (1997) exchange rate pass-through is defined as "the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries." (p. 1248). However, changes in import prices also passed on to consumer prices. Thus, in this paper exchange rate pass-through is seen more broadly as the change in consumer prices that can be attributed to a prior change in the exchange rate.

Two channels of exchange rate pass-through are distinguished in the literature: a direct channel and an indirect channel (see Goldberg and Knetter 1997). Both become more important with an increase in the openness of an economy. The direct way of exchange rate pass-through goes through the external sector of a country, the price of imports.

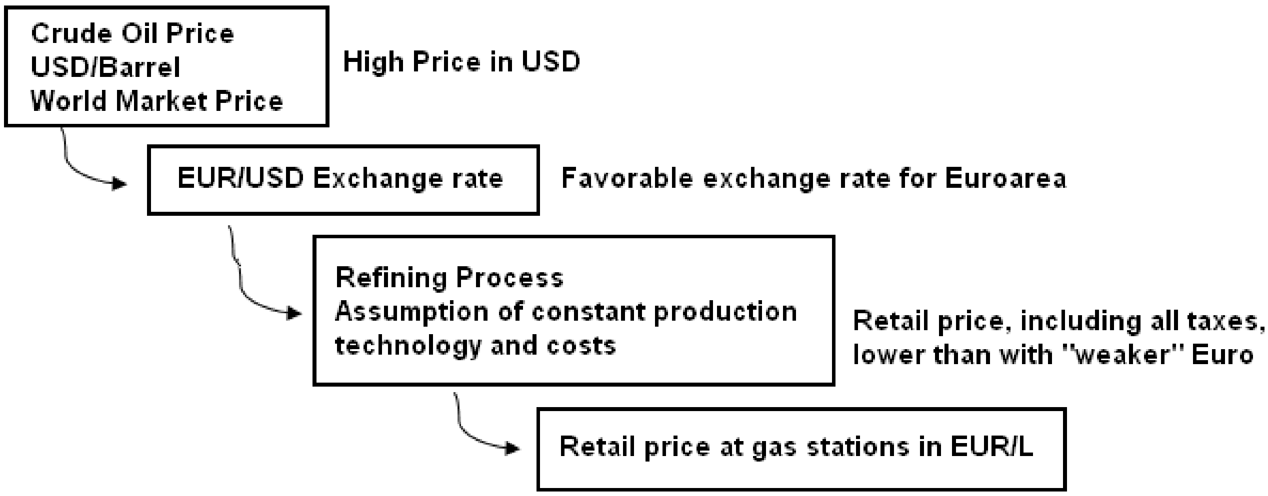
Let E be the exchange rate in terms of domestic currency per unit of foreign currency and P* the foreign-currency price of the imported good, then E x P* represents the domestic-currency price of the imported good. If P* remains fixed and E depreciates (rises) then the domestic-currency price of the imported good will rise in proportion Isard (1994).

The result is called the pass-through from the exchange rate to import prices. Nonetheless, pass-through is only complete if: the markups of prices over costs are constant and the marginal costs are constant say Goldberg and Knetter (1997: 1248). The change in import prices is also likely to translate into changes in the producer and consumer prices of an economy if producers raise their prices in line with the increase in import prices.

The indirect channel of exchange rate pass-through refers to the competitiveness of goods on international markets. A depreciation of the exchange rate makes domestic products relatively cheaper for foreign buyers, and as a consequence exports and aggregate demand will rise and result in an increase of the domestic price level. Since nominal wages are fixed in the short run, real wages will decrease and output will increase. Nevertheless, when real wages will be bid up to their original level over time, production costs increase, the overall price level increases and output falls. So, in the end the exchange rate depreciation leaves a permanent increase in the price level with only a temporary increase in output Kahn (1987).

A further determinant of the pass-through is brought forward by Taylor (2000). According to Taylor (2000) the perceived persistence of shocks affects the size of the pass-through. Firms adjust their prices to a lesser extent to cost and price developments that are expected to be more volatile. In this context Taylor (2000) furthermore provides an explanation for potential changes of the pass-through over time. He argues, that a change to a lower inflation environment e.g. due to a new monetary policy regime, via a reduction in the expected persistence of cost and price shocks, may entail a lower pass-through of shocks to prices. So, the ECB's restrictive monetary policy also plays into the Austrian prices.

In this paper, we try to identify the real factors that determine of the diesel consumer prices by examining the ability of oil prices, the exchange rate and interest rate as well as the harmonized consumer price index without energy costs, to account for movements in the consumer prices in Austria since the beginning of the European Monetary Union in 2002. This notwithstanding, the importance of oil prices and its interaction with the exchange rate movements has been noted by, McGuirk (1983), Krugman (1983), and others. Although these models are appealing, the empirical work in this area has several gaps. It has been shown that exogenous movements in real domestic-currency oil prices seem to capture all the significant long-run movements in real exchange rates for the Euro. Yet several other factors play a more important role. The following figure shows our path of thought to the influences of the oil price on the Austrian consumer prices for diesel. It is important to remember, that in this analysis we assume a ceteris paribus situation in which only the variables in question influence the price of diesel. The price of oil is given exogenously, determined with by the world demand for crude oil. The harmonized consumer price index calculated for the Euro area and Austria by the Eurostat methodology without energy components is also give. The same goes for the remaining variable of the exchange rate and the interest rate.



figures 1: process from crude oil Price (USD/barrel) to the retail price at Austrian gas stations (EUR/l)

DATA AND SUMMARY STATISTICS

Dependent Variable:

- DDIESEL = Diesel – average monthly consumer prices Euro/Liter including taxes

Explanatory Variables:

- DP_OIL= Oil Price – average Europe Brent Spot Price FOB Dollars per liter (158,987/L=Barrel)
- DI_RATE = Interest Rate – average EURIBOR 3M daily rate of the money market
- DEX_RATE = Exchange Rate- average EUR/USD exchange rate including Eurofixes
- DHCPI_EA= Price Level- EA12 Harmonized consumer price index, 2005=100 excluding energy
- DHCPI_AT = Price Level- Austria Harmonized consumer price index, 2005=100 excluding energy

The data we used is comprised of six datasets that have been compiled for Austria and also include the European Monetary Union indicators for the twelve original euro members (EA12). The datasets were downloaded in April 2011 from Eurostat and in the case of the crude oil price from the U.S. Energy Information Administration. The datasets have a dimension of more than one hundred series and all series are available from January 2002 up to December 2010. All data was seasonally adjusted using U.S. Census Bureau's X12 seasonal adjustment program in EViews. Plotting the variable DDiesel against time, we can observe that the variable is trended; the graphs depicting the variables over time can be found in the Appendix A.
Data were seasonally adjusted since the collected figures will normally vary from month to month, be it because of public holidays and vacations in July and December or because of other factors such as weather patterns. We did this –using the U.S. Census Bureau's X12 seasonally adjustment program in EViews – in order to remove changes that are due to seasonal or calendar factors to make for better comparability of the time series on a monthly basis. With seasonality being such a significant factor explaining the fluctuation of the series, controlling for it is an equally significant step in data interpretation and analysis. Several methods have been developed over the years that isolate the time series components of the series, allowing it to be considered appropriately and thus exposing current trends and making it easier to predict the likely evolutions of these trends.

The methods used to arrive at these results have their complementary limitations, but remain useful and relevant tools to adapt and react in a more enlightened way to the information provided by the time series.

A first validity check of the influence of the chosen variables on the diesel price was done by analyzing the diagrams of figure A in the appendix. These diagrams show multiple scatter graphs of the diesel variable against all others and help us specifying the model used in our further analyses. As predicted by common sense, oil prices and diesel prices have the best linear relationship. The worst, not surprisingly, shows between diesel and the interest rate. As there seems to be no relationship of interest for the estimation, we decided to drop this variable in the final estimation. The relationship between the HCPI (EA and AT) as well as the exchange rate are certainly positive, yet to some degree not very clear as to what their influence really is. At a preliminary estimation it was obvious that the

Austrian HCPI did not play a significant role in the determination of the diesel price, accordingly, the variable was also dropped from the final estimation.

Another important manipulation was to make the data stationary. As a matter of fact, all datasets are AR processes, before differencing. The Autocorrelation- (ACF) as well as the Partial Autocorrelation Function (PACF) were almost textbook examples of this. We also conducted a group unit root test, which further provided support for the hypothesis that our variables are non-stationary. The problem with non-stationary or trended data is that a standard OLS regression can lead to incorrect conclusions, in a case of a spurious regression for example. Since the data is not stationary but integrated of the same order I(1), we believe that a conintegrating relationship of the variables is possible. Nonetheless, because of the limitations that OLS estimation have when using non-stationary data, we moved forward and took the first difference, so as to avoid generating potentially spurious regressions, i.e. re-estimating the model in difference.

The table below shows the summary of descriptive statistics for all variables before differencing. (Table 1: does only contain the variables that are important in our analysis. The summary of descriptive statistics of all variables can be found in Appendix A) An important result came from the Jarque-Bera test statistic for testing whether the series are normally distributed. The test statistic, under the null hypothesis of a normal distribution, is distributed with 2 degrees of freedom. The p-values given indicate the probability that Jarque-Bera statistic exceeds (in absolute value) the observed value under the null hypothesis of a normal distribution. In our case, all values but diesel are significant at a 10% level. This means that all variables but diesel show evidence of being normally distributed, but we can't reject that the variable diesel is normally distributed. The null hypothesis is a joint hypothesis of the skewness being zero and the excess kurtosis being 0, since samples from a normal distribution have an expected skewness of 0 and an expected excess kurtosis of 0 (which is the same as a kurtosis of 3). However there is a problem with the chi-square approximation. Since it is overly sensitive (lacking specificity) for small samples, rejecting the null hypothesis when it is in fact true often occurs.

Table 1: Summary of descriptive statistics.

	DIESEL	EX_RATE	HCPI_EA	P_OIL_LIT
Mean	0.951209	1.264027	102.0188	0.365026
Median	0.975545	1.276176	101.6304	0.367636
Maximum	1.359353	1.568162	109.4792	0.734353
Minimum	0.699040	0.856599	94.17798	0.116157
Std. Dev.	0.171774	0.159215	4.700074	0.158222
Skewness	0.196446	-0.526745	-0.004467	0.467755
Kurtosis	2.319381	3.231226	1.695786	2.485003
Jarque-Bera	2.779228	5.234881	7.654742	5.131802
Probability	0.249172	0.072989	0.021767	0.076850
Sum	102.7305	136.5149	11018.03	39.42278
Sum Sq. Dev.	3.157164	2.712401	2363.704	2.678663
Observations	108	108	108	108

As mentioned above, we suspect a conintegrating relationship among the variables, especially the exchange rate and diesel price. We will test this hypothesis and were surprised to find that it was actually not true, a discussion of this is further down.

ECONOMETRIC MODEL AND ESTIMATION METHODS

We did at first use an ordinary least squares estimation of our differenced series, but as it only depicts a static relationship, our main findings will not be presented in this main part of the paper, but can be looked at in Appendix B.

Furthermore, as we think there might be a cointegrating relationship between the retail prices of diesel an the EUR/USD exchange rate, - and both variables are I(1) - we looked at a vector auto regression estimates of both variables. (for our analysis we use the model provided by EViews, which gives us the vector autoregression estimates for 2 lags).

Having examined the plot of the time series and come to the conclusion that the variables 'look' as if they could be moving along the same path, we test for cointegration using the Engle Granger methodology. This follows from Engle and Granger (1987), who pointed out that a linear combination of two or more non-stationary series may be stationary. If such a stationary linear combination exists, the non-stationary time series are said to be cointegrated. The stationary linear combination is called the cointegrating equation and may be interpreted as a long-run equilibrium relationship among the variables.

RESULTS

The vector Autoregression model gives us a set of linear dynamic equations where each variable is specified as a function of an equal number of lags of itself and all other variables in system. (in our case we consider 2 lags). We therefore used an unrestricted VAR(2) model with two endogeneous variables and one exogeneous constant. Looking at the effect of one lagged variable on the other (non lagged variable), we find the coefficients not to be significantly different from zero.

Vector Autoregression estimates:

Sample (adjusted): 2002M03 2010M12
Included observations: 106 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	DIESEL_SA	EX_RATE_SA
DIESEL_SA(-1)	1.210513	0.070934
	(0.09981)	(0.10456)
	[12.1286]	[0.67837]
DIESEL_SA(-2)	-0.272422	-0.068447
	(0.09616)	(0.10074)
	[-2.83312]	[-0.67944]
EX_RATE_SA(-1)	0.176473	1.236578
	(0.09265)	(0.09707)
	[1.90469]	[12.7392]

EX_RATE_SA(-2)	-0.109643	-0.290564
	(0.09322)	(0.09766)
	[-1.17622]	[-2.97525]
C	-0.022745	0.068807
	(0.02305)	(0.02415)
	[-0.98673]	[2.84916]
R-squared	0.973803	0.963215
Adj. R-squared	0.972766	0.961759
Sum sq. resids	0.079585	0.087354
S.E. equation	0.028071	0.029409
F-statistic	938.6022	661.1774
Log likelihood	230.8944	225.9578
Akaike AIC	-4.262158	-4.169014
Schwarz SC	-4.136524	-4.043381
Mean dependent	0.955771	1.271708
S.D. dependent	0.170096	0.150388
Determinant resid covariance (dof adj.)		6.68E-07
Determinant resid covariance		6.06E-07
Log likelihood		457.9202
Akaike information criterion		-8.451325
Schwarz criterion		-8.200057

So testing for cointegration, we used the non-differenced data sets of our second regression. We dropped DP_OIL_SALIT since it is closely associated with the price of Diesel and this might cause problems in the tests. In order to test for the hypothesis that the exchange rate and diesel price are cointegrated, we utilize the methodology suggested by Engle and Granger (1987). In testing we proceeded as follows.

1.) We test whether the assumed time series are I(1) which is a necessary condition for the further testing procedure. To do this we employ the standard Augmented Dickey-Fuller test (ADF-test). We tested for the unit roots in the cases when intercept and trend is present in the regression.

    In this step, we were already able to reject the null hypothesis about the unit root and so conclude that the original time series, EX_RATE_SA and DIESEL_SA., are I(1).

2.) Following this, we stimated the long-run relationships, i.e., the regression on
    DIESEL_SAt = ß0 + ß1EX_RATE_SA + εt, saving regression residuals. (Results are included and commented on below)

3.) Test whether the residuals are stationary using the standard ADF-test. The procedure is the same as in the step 1.). If we are able to reject the null hypothesis about the unit root, It can be conclude that the variables in (1) and (2), respectively, are cointegrated of the orders CI(1,1). (Results are included and commented on below)

4.) What would then follow is the estimation of an error-correction model (ECM). Following the theory in Enders (2004) and using the VAR approach. We would set up a system of equations. When estimating we would take into account two objectives, (i) maintain the models parsimonious, and (ii) at the same time receive εt as a white noise process. Clearly, to fulfill both objectives at a time is in practice, almost impossible. The scope to conduct all this is unfortunately beyond this paper. So we only check for cointegration which is a sufficient check for implying a long run equilibrium relationship.

The results after running the ADF-tests in EViews on the variables EX_RATE_SA and DIESEL_SA were both such that the null Hypothesis could be rejected in all cases. This means that both variables are I(1) processes and we can continue with our analysis. Following we estimated the long run relationship.

Dependent Variable: DIESEL Method: Least Squares
Sample: 2002M01 2010M12
Included observations: 108

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EX_RATE	0.867523	0.062297	13.92557	0.0000
C	-0.145363	0.079362	-1.831657	0.0698

R-squared	0.646574	Mean dependent var	0.951209
Adjusted R-squared	0.643240	S.D. dependent var	0.171774
S.E. of regression	0.102599	Akaike info criterion	-1.697624
Sum squared resid	1.115824	Schwarz criterion	-1.647955
Log likelihood	93.67172	F-statistic	193.9214
Durbin-Watson stat	0.128408	Prob(F-statistic)	0.000000

Null Hypothesis: RESID_EX_DIE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.430551	0.5647
Test critical values:	1% level	-3.492523	
	5% level	-2.888669	
	10% level	-2.581313	

*MacKinnon (1996) one-sided p-values.

The result of the estimate were encouraging, yet we then could not support our hypothesis that there is a cointegrating relationship. We used the saved residuals to run an ADF-test, this result is displayed above. Unfortunately it cannot be concluded that cointegration in the relationships of Diesel_SAt = ß0 + ß1EX_RATE_SA + εt exists, the residuals are non-stationary. We have to note that in our Augmented Dickey-Fuller τ-test the critical values provided by EViews are not correct. The values tabulated by Phillips&Ouliaris have to be used.

After we could not support our expectations we tried to find a cointegrating relationship through the Johansen test, since it is viewed as an improvement to the method by Engel and Granger.

The difference is that in this method testing for cointegration is based an a multivariate generalization of Augmented Dickey-Fuller tests. The equation of the Johansen method looks as follows

$\Delta X_t = \mu + \Pi X_{t-1} + \Psi_1 \Delta X_{t-1} + \Psi_2 \Delta X_{t-2} + \ldots + \Psi_{p-1} \Delta X_{t-p+1} + \varepsilon_t.$

If cointegration should be found the coefficient Π can be seen as Π= αβ', meaning that it consists of two matrices: β, with cointegrating vectors that describe equilibrium relations and α with coefficients that describe how the variables react to deviations from equilibrium.

For reasons of completeness we included the whole regression-output in our paper, though it should be noted, that the estimates for α and β' make no sense in this context, as the Johansen accepts the null Hypothesis (of the rank being zero) and therefore stating that there is no cointegration in our model.

Sample (adjusted): 2002M06 2010M12
Included observations: 103 after adjustments
Trend assumption: Linear deterministic trend
Series: DIESEL_SA EX_RATE_SA
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.081561	12.06290	15.49471	0.1539
At most 1	0.031528	3.299723	3.841466	0.0693

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.081561	8.763182	14.26460	0.3064
At most 1	0.031528	3.299723	3.841466	0.0693

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

DIESEL_SA	EX_RATE_SA
-5.612096	11.49149
10.09157	-5.722372

Unrestricted Adjustment Coefficients (alpha):

D(DIESEL_SA)	0.003649	-0.004142
D(EX_RATE_SA)	-0.006797	-0.003114

1 Cointegrating Equation(s):	Log likelihood	449.2804

Normalized cointegrating coefficients (standard error in parentheses)

DIESEL_SA	EX_RATE_SA
1.000000	-2.047630
	(0.45026)

Adjustment coefficients (standard error in parentheses)

D(DIESEL_SA)	-0.020477
	(0.01533)
D(EX_RATE_SA)	0.038144
	(0.01674)

Our last part of the project, to compensate for the missing continegration relationship, we examined the equation with a simple Granger causality test. The Granger causality test must be run on I(0) series, in our case the differenced variables, DEX_RATE_SA and DDIESEL_SA. Basically, we tested the hypothesis whether the exchange rate helps predict the diesel price. This is done by a simple F-test where the restricted (R) and unrestricted model (UR) are compared. The null hypothesis is that DEX_RATE does not Granger-cause DDIESEL_SA in the first regression and that DDIESEL_SA does not Granger-cause DEX_RATE in the second regression. It is important to note that the statement "Granger causes" does not imply that DDIESEL_SA is the effect or the result of DEX_RATE. Granger causality measures precedence and information content but does not by itself indicate causality in the more common use of the term. The test results are given by:

Pairwise Granger Causality Tests
Sample: 2002M01 2011M03
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Probability
DEX_RATE_SA does not Granger Cause DDIESEL_SA	105	3.83334	0.02488
DDIESEL_SA does not Granger Cause DEX_RATE_SA	105	0.10932	0.89655

The result of the Granger causality is such that the DEX_RATE_SA does not Granger Cause DDIESEL_SA can be rejected while the hypothesis that DDIESEL_SA does not Granger Cause DEX_RATE_SA is rejected. This is encouraging and would be the start of a further in-depth analysis'.

This however will not be discussed in further detail. One should note though, since the price of fuel (i.e. diesel) and the exchange rate do, if plotted, follow the same directions, the result comes as no surprise in that respect. It is also plausible in terms of economic theory; we can thus substantiate our result with the common sense that goes with these types of analyses.

CONCLUSION

It does seem as if Austrian petrol stations pass on the exchange rate changes to the end consumer. This does take a little validity from the theory that retail prices have a very strict 'ratchet effect' – going up easily and remaining stuck at high levels even if overall prices go down. Yet, everything considered, this was expected. European motorists thus pay more for fuel because of the extensive tax regimes in place, not because retail distributors like to 'pick' their exchange rate.

The results, in short, have shown that there exists a relatively good estimation model of the diesel by the exchange rate, consumer price index and oil price. That fact that these variables are all non-stationary has made it necessary to use their first difference for the model estimations. So, we have estimated the changes among the sample periods. This allows the conclusion that the consumer prices for diesel have not increased by the same amount as they would have given a less favorable exchange rate. The fact that the main variables of interest, exchange rate and price of diesel, are not conintegrated allows for a further expansion of the breadth of analysis, especially the effects of the Granger causality test are further analyzed.

A further, slightly more complex question worth investigating in the future would be *why* the Euro has such strength vis-à-vis the dollar. Given the heaps of speculation about a possible collapse of the Eurozone due to some of its members' precarious balance sheets and the disastrous effects of the contagious nature of Europe's banking system; it is rather surprising that the currency hasn't been stomped on by the markets. Given the last few inflation figures – largely a result of the comeback of energy prices – we should expect consumer prices to receive another bump should the exchange rate finally falter in light of new speculations of default. Of course, that could be one piece of reasoning behind the ECB's recent raise of rates.

The recent banking, finance, and insolvency crisis as increased the volatility of the Euro and in fact have brought depreciationary pressures onto it. However, since the United States faces a similar problem (record debt, historically high debt levels with a tendency to 100% of GDP, and especially now the threat of insolvency due to bipartisan turmoil) means that even the U.S. dollar is in low flight. Thus, the decline of the euro is partly compensated. Nonetheless, if one compares the Euro, with the Swiss franc, for example, one quickly sees that there has been a massive appreciation of the franc. In the last 4 months this was in the excess of 17%, have depreciated from 1 € = CHF 1.32 to about 1.15 CHF/€. In November 2009 the value was as high as 1.50 CHF/€. In July 2008, the height of the last crisis brought the Chinese Yuan to 11 per Euro. In July 2010 the Euro depreciated against the Yuan to a ratio of 8.5 Yuan/Euro, and that even though the Chinese have kept their currency deliberately undervalued. So it's not that the Euro is exceptionally strong, but it does in fact seem that before the Swiss franc, the Euro is the best worst alternative. This, and the strong demand for European exports, has helped diesel consumers to enjoy lower diesel prices as the exchange rate effects are passed through to them. Not to the full scale as prices are sticky downwards, but to a good measure.

We want to stress the fact that we exclusively looked at the EUR/USD exchange rate and that we have not accounted for the cross effects among the world's major currencies.

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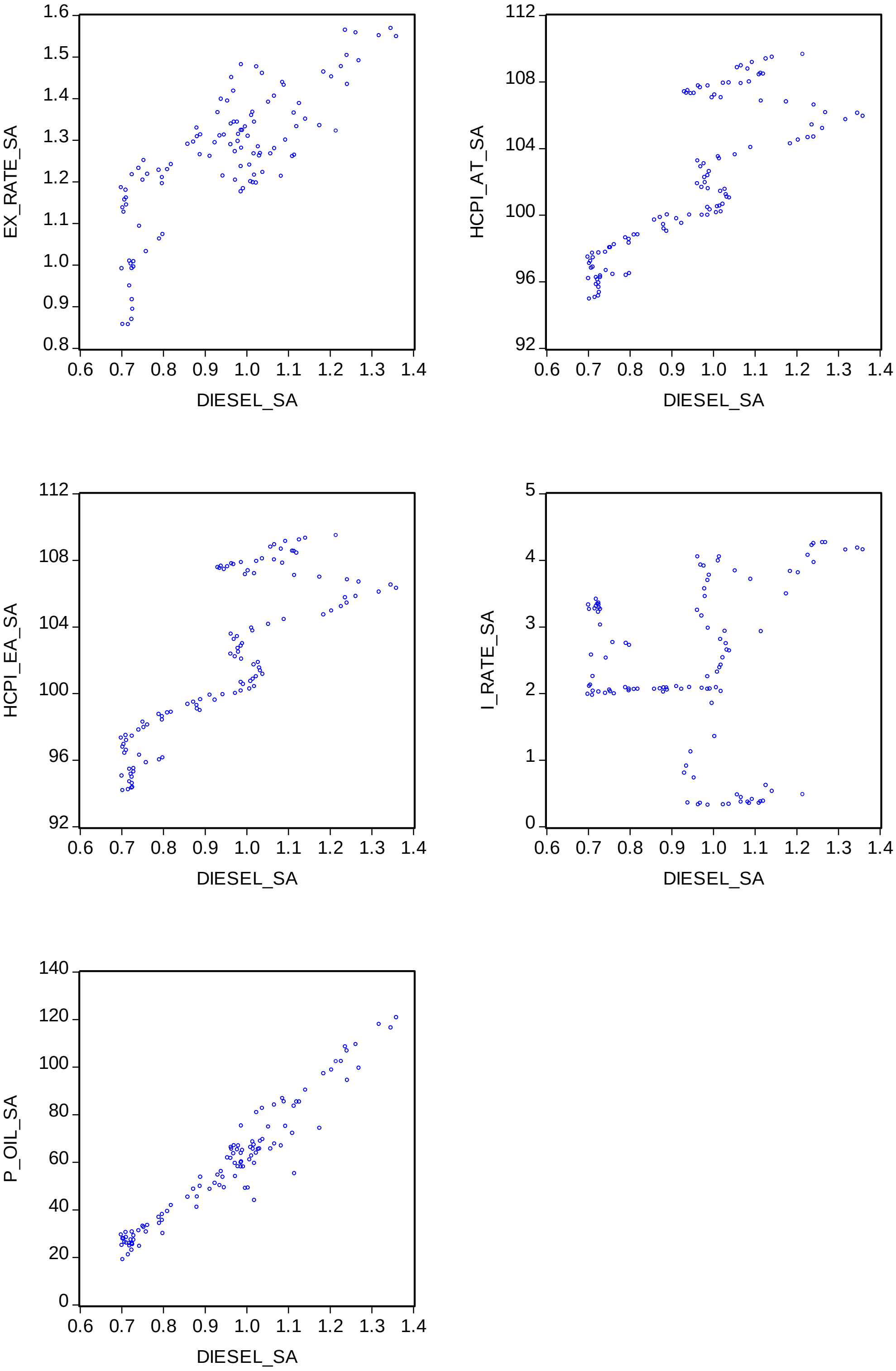
APPENDIX A

Figure A



Full Output of Table 1.
Summary descriptive statistics

	DIESEL	EX_RAT	HCPI_AT	HCPI_EA	I_RATE	P_OIL_LIT
Mean	0.951209	1.264027	102.0212	102.0188	2.382680	0.365026
Median	0.975545	1.276176	101.3230	101.6304	2.252798	0.367636
Maximum	1.359353	1.568162	109.6570	109.4792	4.266074	0.734353
Minimum	0.699040	0.856599	94.95699	94.17798	0.322562	0.116157
Std. Dev.	0.171774	0.159215	4.446169	4.700074	1.202812	0.158222
Skewness	0.196446	-0.526745	0.160208	-0.004467	-0.283171	0.467755
Kurtosis	2.319381	3.231226	1.691571	1.695786	2.109092	2.485003
Jarque-Bera	2.779228	5.234881	8.165940	7.654742	5.015073	5.131802
Probability	0.249172	0.072989	0.016857	0.021767	0.081469	0.076850
Sum	102.7305	136.5149	11018.29	11018.03	257.3294	39.42278
Sum Sq. Dev.	3.157164	2.712401	2115.221	2363.704	154.8030	2.678663
Observations	108	108	108	108	108	108

APPENDIX B

We use standard ordinary least squares as the estimation method of our differenced series. As the differenced series show the rate of change, we should get estimates reflecting how exchange rates impacted on the changes in the diesel prices, along with the harmonized price index and oil price acting as control variables. Our first model looks as follows:

$DDIESEL_t = ß_0 + ß_1 DEX\_RATE + ß_2 DHCPI\_EA + ß_3 DP\_OIL\_LIT + ß_4 DI\_RATE + ß_5 DHCPI\_AT + \varepsilon_t$

Where the first 'D' means differenced. Given our hypothesis that the exchange rate influences Austrian diesel prices, it is included as our main variable of interest, along with the oil price, as a control variable. Additionally, we have the Austrian and the European Harmonized Price Index, without energy, to act as proxies for inflation. The interest rate is included as well, despite the findings from Figure A (Appendix A)given its importance in macroeconomic considerations.

Our second model is more parsimonious:

$DDIESEL\_SA_t = ß_0 + ß_1 DEX\_RATE\_SA + ß_2 DHCPI\_EA\_SA + ß_3 DP\_OIL\_SALIT + \varepsilon_t$

Next, we test the model specifications in terms of its qualities in explaining the changes, select the better model and analyze its predictive potential.

Since we have subjected the variables to the previously mentioned unit root tests, we know that all of them are I(1).

Our first model's results are as follows:

Dependent Variable: DDIESEL
Method: Least Squares
Sample (adjusted): 2002M02 2010M12
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEX_RATE	-0.226448	0.067639	-3.347889	0.0011
DHCPI_AT	-0.015355	0.014779	-1.039006	0.3013
DHCPI_EA	0.055216	0.020544	2.687703	0.0084
DI_RATE	0.018757	0.012804	1.464924	0.1460
DP_OIL_LIT	0.701420	0.062123	11.29083	0.0000
C	-0.002962	0.003370	-0.879086	0.3814

R-squared	0.610132	Mean dependent var	0.004786
Adjusted R-squared	0.590832	S.D. dependent var	0.029977
S.E. of regression	0.019175	Akaike info criterion	-5.015933
Sum squared resid	0.037137	Schwarz criterion	-4.866055
Log likelihood	274.3524	F-statistic	31.61246

Durbin-Watson stat	2.150820	Prob(F-statistic)	0.000000

We notice that whilst the specifications are reasonably sound overall, the Austrian HCPI (DHCPI_AT_SA) is insignificant at the 10% level, as is the interest rate (DI_RATE_SA). Noting that the pair wise cross correlation between the European and the Austrian HCPI figures stands at 0.997184, this is not surprising. We proceed to drop both variables, arriving at our second regression results as follows:

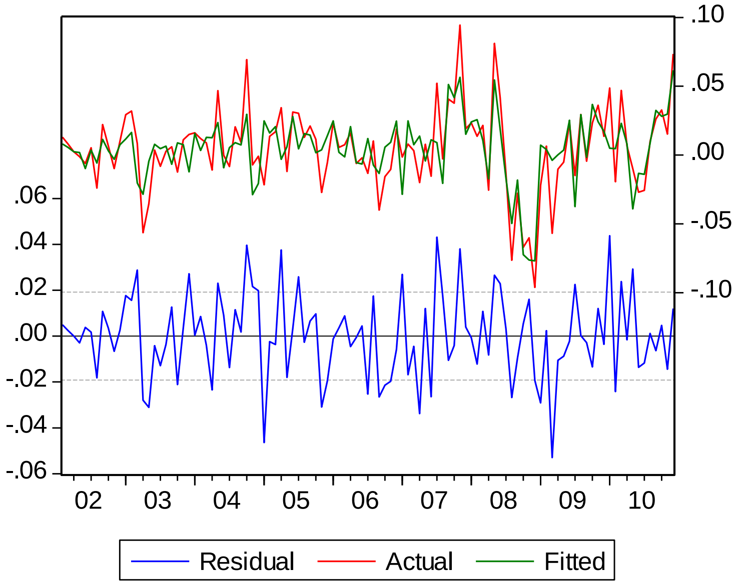
Dependent Variable: DDIESEL
Method: Least Squares
Sample (adjusted): 2002M02 2010M12
Included observations: 107 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DEX_RATE	-0.212118	0.067644	-3.135786	0.0022
DHCPI_EA	0.048545	0.018503	2.623677	0.0100
DP_OIL_SLIT	0.715761	0.060347	11.86070	0.0000
C	-0.004737	0.003245	-1.459886	0.1474

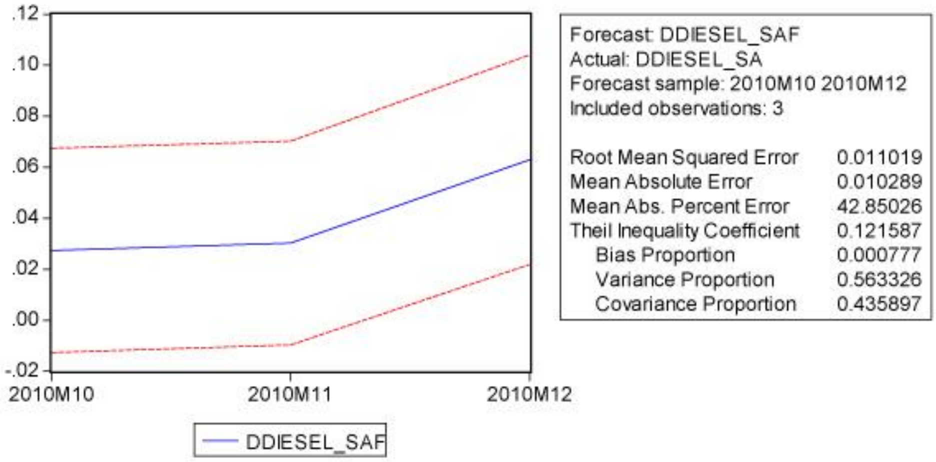
R-squared	0.597017	Mean dependent var	0.004786
Adjusted R-squared	0.585279	S.D. dependent var	0.029977
S.E. of regression	0.019305	Akaike info criterion	-5.020228
Sum squared resid	0.038387	Schwarz criterion	-4.920310
Log likelihood	272.5822	F-statistic	50.86456
Durbin-Watson stat	2.038357	Prob(F-statistic)	0.000000

The Akaike and Schwarz criteria are slightly better than in our first estimation. The adjusted R^2, for what it's worth, is satisfactory at around 59%, having barely budged when compared to the first regression. Unsurprisingly, the oil price is highly significant, with a coefficient of .72. The harmonized price index (excluding energy), is *just* significant at the 1% level, with a coefficient of 0.05. Headline inflation has thus contributed 5% to the change in the diesel price in the given period. Our coefficient of interest, the exchange rate, is negative, with a value of -.21 and significant at the 5% level. This indicates that the exchange rate movements have resulted in roughly 21% lower rises annually in the diesel price over the 8 years observed. This should be good news for any motorists out there, which would pay for better Euro area competitiveness on the international market with a significantly higher diesel price.
Since our results fit neatly into economic theory, we can proceed by looking at how well our model is specified, and how well it predicts 'itself' and the future.

The fitted data looks to reproduce the actual data quite satisfactorily, reacting to changes and following short-term trends rather well. The residuals do not seem to stray from their mean of zero for too long either, as is shown in the following residual graph.



Further, we checked for serial correlation using the Ljung-Box Q-statistic. From it we could not support serial correlation between the residuals, further undermining the good fit of the estimation.
In terms of forecasting, the model has a small RMSE speaking for it, and seems to reproduce the rise in prices at the end of 2010 quite well. It's reassuring, that our results are replicated in a meaningful way.



Correlation does not necessarily imply causation in any meaningful sense of that word. The econometric graveyard is full of magnificent correlations, which are simply spurious or meaningless.