An Analysis of German Effects on the Austrian Business Cycle

By

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I. Introduction

Germany is one of the major economic forces in continental Europe. It plays a significant role in the European Economic Community and the European Union. Studies on the relationships between European countries usually assign Germany as the focus country. For example, Bayoumi and Eichengreen (1993) consider Germany and its neighboring countries to be the "core" of the European Monetary Union and the rest of Europe to be the "periphery." In fact, it is argued that the European Monetary System is a greater Deutsche mark zone (Giavazzi and Giovannini 1989). Undoubtedly, developments in the German economy have significant implications for both its neighboring countries. The German effects are perceived to be particularly strong for Austria, which is a direct neighbor of Germany and has its exchange rate pegged to the Deutsche mark.

Empirically, the interaction between the Austrian and German economies is typically analyzed by examining the output correlations of these two countries. For example, Winckler (1993) shows that the annual Austrian and German output growth rates are correlated at different lags. He argues that "the parallel development of macroeconomic variables in Germany and Austria ... can hardly be explained by the export-import link ... [it] is probably the outcome of the pragmatic orientation of Austrian policy institutions towards West German economic policy." Using several macroeconomic indicators, Brandner and Neusser (1992,

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1994) lend further support to the dependency of Austria on Germany. Brandner and Jaeger (1992) show that Austria is more synchronized with the core of Germany than most of the German "Länder" (states in Germany).

Using a time series framework, this paper examines the Austro-German relation by assessing the interactions between the Austrian and German economies. In pursuance of Winckler's argument that policy decisions are the forces behind the interaction between Austrian and German economies, we use industrial production as a proxy for output. In this way we leave out the services sector, which in Austria is largely dominated by the tourism industry. In addition to computing correlations, advanced time series econometric techniques are used to study comovements between industrial production in Austria and Germany. Specifically, the cointegration technique is used to discern the short-term and long-term output comovements. The contributions of the German output shocks on Austrian output are assessed using impulse response and forecast error variance decomposition analyses.

We find that the Austrian and German industrial production indexes are cointegrated; that is, the two national output series move together in the long run. Using the error correction model based on the cointegration result, we show that German output Granger-causes Austrian output. That is, movements in the German output help explain variations in Austrian output. These results are supportive of the claim that Austria is closely related to and affected by Germany. However, the impulse response and forecast error variance decomposition analyses reveal that Austrian shocks are largely responsible for the unexpected variability of Austrian output. Shocks from Germany account for only a small portion of unpredictable Austrian output fluctuations.

The rest of the paper is organized as follows: Section II presents the preliminary data analysis. Section III reports the cointegration test result and the related error correction model estimation. Results from the impulse response and forecast error variance decomposition analyses are also reported in this section. Section IV contains some concluding remarks.

II. Preliminary Analysis

Monthly indexes of industrial net production are used as proxies for aggregate output. The sample period covers the years 1962.1–1994.12. The German data were provided by the Statistisches Bundesamt in Wiesbaden and were seasonally adjusted using the X-11 procedure. The sea-

Table 1 – *Unit Root Test Results*

	Levels	First differences
Germany	−2.22 (11)	−10.72* (3)
Austria	−1.56 (9)	−10.06* (4)

Note: The ADF test statistics calculated from the levels and first differences of the industrial production indexes in logs are reported. The lag parameters selected by the Akaike information criterion are in parentheses next to the statistics. Critical values from Cheung and Lai (1995) are used. * indicates significance at the five percent level. The unit root hypothesis is not rejected for the data series but is rejected for their first differences.

sonally adjusted Austrian data on industrial production were extracted from the OECD database.

The augmented Dickey and Fuller (ADF) test allowing for both an intercept and a time trend is employed to determine if there is a unit root in the data series. Let X_{it} be the industrial production index of country i (i = Germany and Austria) at time t. The ADF test is based on the regression equation:

$$\Delta X_{it} = \mu_0 + \mu_1 t + \alpha X_{it-1} + \beta_1 \Delta X_{it-1} + \ldots + \beta_p \Delta X_{it-p} + \varepsilon_t, \quad (1)$$

where Δ is the first difference operator and ε_t is an error term. The Akaike information criterion (AIC) is used to determine p, the lag parameter. Results of applying the ADF test to the data and their first differences are shown in Table 1. The null hypothesis of a null root is not rejected for the data series and is rejected for the first-differenced data. Thus, there is one unit root in each of the two industrial production series, a result that is consistent with the literature. In the subsequent analysis, we assume the data are difference stationary.

The sample correlation coefficient for the first-differenced industrial production data is 0.18. The sample statistic suggests that the Austrian and German economies are related. More vigorous analyses of the interactions between these output series are given in the following section.

III. Long-Run and Short-Run Interactions

The cointegration technique and the implied error correction model are used to study the long-run and short-run interactions. The long-run relationship is interesting for, at least, two reasons. First, it indicates whether permanent shocks in the two countries are common or idiosyncratic. Second, information about the long-run behavior is essential for specifying an appropriate model to analyze short-run interactions. A misspecified long-run relationship can lead to erroneous inferences on short-run dynamics.

1. Cointegration Test

The Johansen (1991) procedure is used to test for the presence of cointegration. Let X_t be the 2×1 vector (X_{it}), i = Germany and Austria. The Johansen test statistics are devised from the sample canonical correlations (Anderson 1958; Marinell 1995) between ΔX_t and X_{t-p}, adjusting for all intervening lags. The procedure is based on the regression equations

$$\begin{aligned} \Delta X_t &= \mu_1 + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \varepsilon_{1t}, \\ X_{t-p} &= \mu_2 + \sum_{i=1}^{p-1} \Gamma_i \Delta X_{t-i} + \varepsilon_{2t}, \end{aligned} \quad (2)$$

where μ_1 and μ_2 are constant vectors. The lag parameter, p, is identified by the AIC. The trace statistic,

$$t_r = -T \sum_{j=r+1}^{n} \ln(1-\lambda_j), \quad 0 \le r \le n \quad (3)$$

is used to test the hypothesis that there are at most r cointegration vectors, where $\lambda_i s$ $(\lambda_1 \ge \ldots \ge \lambda_n)$ are the squared canonical correlations between ΔX_t and X_{t-p}, adjusting for all intervening lags. The hypothesis of r against the alternative of $r+1$ cointegration vectors is tested by the maximum eigenvalue statistic,

$$\lambda_{r:r+1} = -T \ln(1-\lambda_{r+1}) . \quad (4)$$

The Johansen test results are reported in Table 2. Both the trace and maximum eigenvalue statistics suggest that there is one cointegrating relationship between the industrial production indexes of these two countries. The estimated cointegrating vector, with the coefficient of the German variable normalized to one, is (1, −0.68). The sample statistics for testing the null hypothesis that the coefficients are individually zero are, 14.42 and 14.49, respectively. Under the null hypothesis, these statistics have an asymptotic $\chi^2-(1)$ distribution. Therefore, all

Table 2 – *Cointegration Test Results*

	Trace statistic	Maximum eigenvalue statistic
$r = 0$	26.10*	20.31*
$r \leq 1$	5.79	5.79

Note: The trace and maximum eigenvalue statistics computed from the bivariate system consisting of German and Austrian production indexes are reported. The lag parameter is selected using the Akaike information criterion. Critical values from Cheung and Lai (1993) are used. * indicates significance at the five percent level. The elements of the cointegrating vector are 1 (Germany) and −0.68 (Austria). The $\chi^2(1)$ statistics for testing the significance of these elements are 14.42 and 14.49, respectively.

two coefficients are statistically significant at the conventional 5 percent level.

According to the Johansen test, industrial production indexes of Germany and Austria are cointegrated. These economies experience common permanent shocks that drive their long-term trends and, thus, share a common long-run component in their industrial production data. The result lends a strong support to the view that these two economies are closely linked via some common permanent shocks.

2. Short-Run Interactions

Given the cointegration result, we use a vector error correction (VEC) model to explore the effects of short-term variation and deviation from the cointegrating relationship on industrial production indexes. Specifically, the changes in industrial production indexes can be modeled using the following VEC structure

$$\Delta X_t = \mu + \sum_{i=1}^{p} \Gamma_i \, \Delta X_{t-i} + \alpha EC_{t-1} + \varepsilon_t \,, \qquad (5)$$

where EC_t is the error correction term given by $\beta' X_t$, and β is the cointegrating vector. The responses of industrial production growth rates to short-term output movements are captured by the Γ_i coefficient matrices. The α coefficient vector reveals the speed of adjustment to the deviation from the long-run relationship between the industrial production indexes. Coefficient estimates of the VEC model are presented in Table 3.

Table 3 – *The Vector Error Correction Model*

	Germany	Austria
ΔX (Germany, $t-1$)	−0.56* (0.06)	0.03 (0.05)
ΔX (Germany, $t-2$)	−0.21* (0.06)	0.14* (0.06)
ΔX (Germany, $t-3$)	0.10 (0.05)	0.12* (0.05)
ΔX (Austria, $t-1$)	0.00 (0.05)	−0.59* (0.05)
ΔX (Austria, $t-2$)	0.06 (0.05)	−0.31* (0.05)
ΔX (Austria, $t-3$)	0.02 (0.05)	−0.14* (0.05)
$EC(t-1)$	−0.04 (0.03)	0.10* (0.03)
Constant	0.03 (0.02)	−0.06* (0.02)
Q5	0.52 (0.99)	0.28 (0.99)
Q15	4.74 (0.99)	5.58 (0.99)
S.E.	0.009	0.008
Adjusted R^2	0.296	0.291
Log Likelihood	1,288	1,313

Note: Coefficients of the VEC models are reported. Heteroskedasticity-consistent standard errors are given in parentheses. * indicates significance at the five percent level. Q5 and Q15 give the Box-Pierce statistics based on the first 5 and 15 autocorrelation coefficients from the estimated residuals. p-values are reported in parentheses. S.E. gives the standard error of the equation.

The German and Austrian industrial production changes have asymmetric effects on each other. Two of the three lagged German industrial production terms help explain movements in Austrian output. The coefficients are both positive and significant. That is, an increase in German output is likely to be followed by an upward swing in the Austrian output. On the other hand, the German variable is not explained by any lagged changes in Austrian industrial production. Using the Granger causality terminology within the VEC framework (Granger and Lin 1995; Toda and Phillips 1993), changes in German industrial production cause the Austrian ones. Further, the significance of the correction term indicates that only the Austrian economy responds to deviations from the equilibrium relationship that governs the long-run movements of national output series.

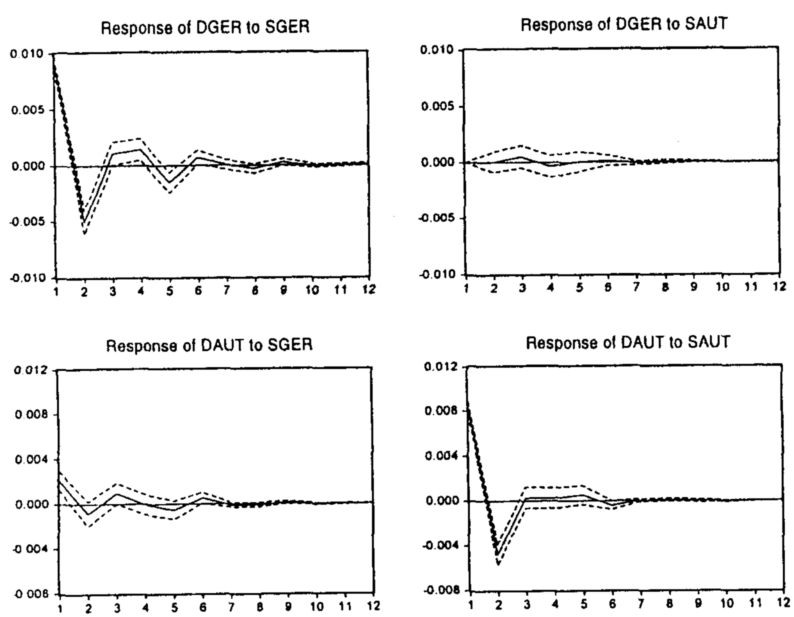
So far, the empirical results are in accordance with the view that there are close linkages between the German and Austrian economies. The two economies share a common trend in the long-run industrial production. On short-term variation, the Austrian economy appears to systematically respond to changes in German industrial output. Put the results together, there seems to be evidence that the Austrian policies are mainly oriented toward the German ones.

3. Impulse Responses and Forecast Error Variance Decomposition

To obtain a better understanding of the effects of output shocks on Austria, we use the VEC model reported in Section III.2 to compute the cumulative impulse responses of national industrial output growth rates to one-standard-deviation shocks. The rankings of the variables are Germany and Austria. The impulse responses mirror the coefficients of the moving average representation of the VEC model and track the effects of a shock on the endogenous variables at a given point of time.

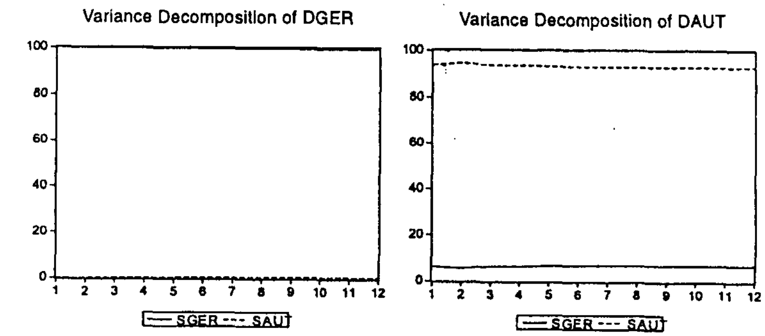
The impulse responses and the associated confidence intervals are graphed in Figure 1. It is evident that the Austrian industrial production

Figure 1 – *Impulse Responses of Austrian and German Industrial Production Growth to National Shocks: Response to One–S.D. Innovations ±2 S.E.*



Note: The solid lines trace the impulse responses of Austrian (DAUT) and German (DGER) industrial production growth to Austrian (SAUT) and German (SGER) shocks. The 2-standard error confidence intervals (dotted lines) are generated by 1000 Monte Carlo replications.

Figure 2 – *Forecast Error Variance Decomposition for the Austrian and German Industrial Production Growth*



Note: The proportions of the forecast error variance of national industrial production growth ascribed to Austrian and German shocks are traced by the lines labeled SAUT and SGER.

growth responds more to shocks emanating from Austria than to those from Germany. The effects of German output shocks appear to be short-lived and last only for one–two months. Consistent with the VEC model estimation results, output shocks originating from Austria have virtually no impact on Germany. German shocks are mainly responsible for variations in German output growth.

While the impulse responses provide information on the effect of a standardized output shock, they do not indicate the extent to which a given shock contributes to the level of uncertainty in industrial output growth. To further assess the relative importance of output shocks, we decompose the forecast error variance of national industrial output growth into parts that are attributable to shocks emanating from Germany and Austria.

The proportions of forecast error variances are graphed in Figure 2. For the Austrian output growth, the German shock accounts for a very small percentage of the total forecast error variance. Output shocks from Austria account for more than 90 percent of the forecast uncertainty. That is, the uncertainty in Austrian industrial output growth is mainly generated by shocks to its own economy. External shocks from Germany play a limited role in affecting Austrian output uncertainty. Similarly, uncertainty in German output growth is largely determined by shocks to the German economy.

Despite the close ties between Austria and Germany revealed by the cointegration technique and VEC model, the impulse response and forecast error variance decomposition results manifest that Austrian, and not German, output shocks are the driving forces behind the Austrian output variability and uncertainty. While German output Granger-causes Austrian output, German shocks only contribute a relatively small portion to Austrian output fluctuations.

IV. Concluding Remarks

Using advanced time series econometric techniques, we study the interaction between the German and Austrian economies. Austria and Germany are found to share common permanent stochastic shocks that drive the long-run trends of their industrial output. Further, Austrian industrial output is Granger-caused by the German one. This finding is supportive of the claim that the German economy has substantial influences on the Austrian economy.

The impulse response and forecast error variance analyses, on the other hand, indicate that the effects of German output shocks on Austrian output growth tend to be short-lived. In fact, the Austrian output uncertainty is largely attributable to shocks to its own economy. In light of this finding, one should qualify the German influences on Austria. Derived from the exchange rate arrangement and trade activity, the Austrian and German economies are closely linked and the former one appears to react to the latter. However, shocks to Austria itself are mainly responsible for the unexpected variations in the Austrian output.

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