Christian Ragacs

Employment, productivity, output and minimum wage in Austria: a time series analysis

Paper

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EMPLOYMENT, PRODUCTIVITY, OUTPUT AND MINIMUM WAGE IN AUSTRIA:
A Time Series Analysis*

CHRISTIAN RAGACS

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September 1993

* For helpful comments I am grateful to Thomas Grandner and Andrea Grisold. Of course I am responsible for all remaining errors.

Address of the author:

Christian Ragacs
Department of Economics
Vienna University of Economics and Business Administration
Augasse 2-6
A-1090 Vienna
AUSTRIA
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Abstract

This paper evaluates stylised facts for the Austrian industry. I execute a time series analysis for minimum wage, productivity, output and employment. Tests for co-integration and Granger-causality are done. The results are in contrast to most empirical studies that analyse the empirical effects of minimum wages on employment. Especially no negative impact of minimum wage on employment was found.
1. Introduction

**Problem**

Working paper 20 of the Viennese University of Economics and Business administration evaluated the effects of minimum wages on employment in a comparative static, partial analytic framework for the Austrian case.\(^1\) Growth rate of employment was a function of output, productivity and minimum wage. The empirical result at first sight seems to force the standard "neo-classical" theses that minimum wages reduce employment. The problems concerning the used model are that minimum wage, output and productivity have to be independent and the causal relationship between the variables has to work into the "right" direction.

In spite of the theoretical and empirical analysis done in the study mentioned above and most other studies about minimum wages that predict negative effects on employment\(^2\), arguments of the Austrian labour union force the implementation of minimum wages.\(^3\) Instead of comparative statics a dynamic argumentation is used which states that minimum wages may cause output growth and hence maybe higher employment in the future. One of the reasons could be that minimum wages complicate the use of "cheap labour" and therefore in the long run they should force the entrepreneurs to use better technologies to improve productivity and output growth. Increased productivity and/or output may cause higher employment. Hence, in contrast to most theoretical research, there is not a direct, but an indirect effect of minimum wages supposed, and this under a dynamic point of view.

In this paper I used employment, average minimum wage, hourly labour productivity and output of the aggregated Austrian industry for a time series analysis.\(^4\) I use methods which are more or less "data-driven". I try to "let the data speak" without an "a priory" applying of economic theory. Of course, some economic theory exists in the background already. It lead to the selection of the variables to be analysed, but the results of this chapter do not describe the results of a well formulated theoretical model. On the contrary stylised facts are prepared which may help to discuss the effects of minimum wages in a new theoretical framework.

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\(^{1}\) See: RAGACS 1993.

\(^{2}\) See: RAGACS 1993.

\(^{3}\) AUSTRIAN LABOUR UNION 1990, p.16.

\(^{4}\) For a time series analysis of the average wage rate in Austria see: THURY 1990.
The analysis done in this paper is based on the estimation of vector autoregressive regressions (VAR), a vector of variables at time t is regressed at its forgone values.\(^5\) The tests done in this paper are sensitive to the properties of the time series and I have to test for them: Especially they have to be stationary. "A stochastic process is said to be wide-sense or covariance stationary if the means, variances and covariances of the process are constant through time."\(^6\) For the discussion of the relationship among the four variables I use two concepts. I first ask for co-integration between the used variables. Broadly speaking, the existence of co-integration between two variables would imply that there exists a long-term equilibrium relationship between these two variables. I will ask for this relationship. After doing this, I use the concept of Granger-causality to discuss the effect of minimum wages on employment, productivity and output, and vice versa. A variable \(x_{1t}\) is said to be Granger-caused by some other variable \(x_{2t}\) if information about past and present \(x_{2t}\) helps to improve forecasts of \(x_{1t}\).

The exact formal definition of stationarity, co-integration and Granger-causality is done later in this paper\(^7\).

I have to mention, that I am only interested in the relationship between the minimum wage and every other variable alone. Hence I discuss bivariate systems.

**Structure of the paper**

In chapter two I shortly describe the used data set. Chapter three analyses the time series properties, namely integration and co-integration. In chapter four I execute Granger-causality tests. Chapter five sums up the central results.

2. Used data set

The analysis was done for aggregated Austrian industry.

Used variables are: Employment \((N_t)\), real output \((Y_t)\), real hourly labour productivity \((Y_t/(N_t*ht))\), where \(ht\) describes average working time of people, and real

\(^5\) For an introduction to this kind of models see for instance: JUDGE, HILL, GRIFFITHS, LÜTKEPOHL, LEE 1988, p. 680 and p. 755.


\(^7\) See pages 5, 9 and 13.
minimum wage ($w_t$). The used data set is identical to that of RAGACS 1993. I use yearly data from 1969 to 1990.\textsuperscript{8} Source for all data except the minimum wage was the database of the WIFO.\textsuperscript{9} Nominal output data are the nominal net products. Gross nominal minimum wages are taken from BUNDESKAMMER DER GEWERBLICHEN WIRTSCHAFT.\textsuperscript{10} For deflationing I used the price index of the Austrian industry ("Preisindex des Beitrags der Industrie zum BIP").

I used the real minimum wage for my analysis although the published minimum wages are nominal wages. Hence I have to give reason why to do this. Even if the wages are nominal wages, of course the price development is a leading factor for the bargaining situation. Therefore, even if minimum wages are not defined in real terms, the expectations of the inflation rate are a central point for the rise in the "nominal" wage. Hence I have to care about two possible failures. I could use only the nominal minimum wage and neglect the price movement or I could use the real minimum wage and neglect the failure between the price expectations and the actual prices. I decided to do the second.

All tests were done with the logarithms of the time series.

3. Time series properties

3.1. Integration of time series

One necessary characteristic for the tests done later is that the time series have to be stationary. Stationarity is defined as follows: If $\mu$ describes the arithmetic mean and $\tau_t$ is an autocovariance function of the process $y_t$, then "a stochastic process $y_t$ is stationary, if

i. $E[y_t] = \mu$ for all $t$.

ii. $\text{var}(y_t) < \infty$ for all $t$.

iii. $\text{cov}(y_t, y_{t+k}) = E[(y_t - \mu)(y_{t+k} - \mu)] = \tau_k$ for all $t$ and $k$.\textsuperscript{11}

\textsuperscript{8} The published data for minimum wages may only be interpreted as yearly data. See: RAGACS 1993.

\textsuperscript{9} WIFO = Austrian Institute for Economic Research.

\textsuperscript{10} BUNDESKAMMER DER GEWERBLICHEN WIRTSCHAFT.

\textsuperscript{11} JUDGE, HILL, GRIFFITHS, LÜTKEPOHL, LEE 1988, p. 679.
Tests for stationarity:

The tests for stationarity are based on the Dickey Fuller (DF) and the augmented Dickey fuller test (ADF): First, consider an autoregressive process of order one (AR1):

1) \( y_t = \beta_1 + \beta_2 y_{t-1} + \varepsilon_t \)

This process is stationary if \( |\beta_2| < 1 \). The test is done at the boarder of \( \beta_2 = 1 \). Transforming of 1) leads to the following test regression:

2) \( \Delta y_t = \beta_1 + (\beta_2 - 1)y_{t-1} + \varepsilon_t \) \hspace{1cm} (Dickey Fuller Test)

The null hypothesis is \((\beta_2 - 1) = 0\) which means that \( y_t \) is not stationary in levels. The alternative hypothesis is, that \((\beta_2 - 1)\) is smaller than 0.

Second, imagine an AR2 process:

3) \( y_t = \beta_1 + \beta_2 y_{t-1} + \beta_3 y_{t-2} + \varepsilon_t \)

Transforming leads to the following estimation regression:

4) \( \Delta y_t = \beta_1 + (\beta_2 + \beta_3 - 1)y_{t-1} + \beta_3 \Delta y_{t-1} + \varepsilon_t \) \hspace{1cm} (Augmented Dickey Fuller Test)

The augmented Dickey Fuller test may be estimated for longer AR lags too. The calculation of the test regression is similar to that of an AR2.

The null hypothesis for nonstationarity is: \((\beta_2 + \beta_3 - 1) = 0\). The alternative hypothesis for stationarity is \((\beta_2 + \beta_3 - 1) < 0\). Hence, in order to achieve stationarity, the t-values have to be smaller than the critical values of the test statistics. The test statistics do not follow the t-distribution, but tables of significance levels were estimated by DICKEY and FULLER (1979). In order to reflect our small number of available observations, I calculated the exact critical values for integration.
and co-integration based on the table published by MACKINNON in 1990.\textsuperscript{12} Those values are printed in the tables if needed.

\textit{Integration of time series:}

If a series is not stationary, differencing may help to transform it into a stationary one. Hence I have to ask for the grade of integration of the time series: "A series with no deterministic component which has a stationary, invertible, ARMA representation after differencing d times, is said to be integrated of order d, denoted $y_t - I(d)$."\textsuperscript{13} In our case I focus on the cases $I(0)$ and $I(1)$.

To test the order of integration I calculated the Dickey Fuller and the augmented Dickey Fuller tests for the basic time series and for first differences. Stationarity was achieved with first differences. Therefore in the following table I show the results for levels and first differences:

\textsuperscript{12} See: MACKINNON 1990.

\textsuperscript{13} ENGLE, GRANGER 1987, p. 252. For definition of an ARMA process see for instance: JUDGE, HILL, GRIFFITHS, LÜTKEPOHL, LEE 1988, p. 696 ff.
### Table 1: Dickey Fuller test and augmented Dickey Fuller test for stationarity:

<table>
<thead>
<tr>
<th>Variables</th>
<th>DF(1)</th>
<th>ADF(2)</th>
<th>ADF(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>empl</strong></td>
<td>-0.284</td>
<td>-1.184</td>
<td>-0.494</td>
</tr>
<tr>
<td></td>
<td>(0.303)</td>
<td>(0.493)</td>
<td>(0.900)</td>
</tr>
<tr>
<td><strong>prod</strong></td>
<td>-0.819</td>
<td>-0.367</td>
<td>-0.380</td>
</tr>
<tr>
<td></td>
<td>(0.364)</td>
<td>(0.513)</td>
<td>(0.420)</td>
</tr>
<tr>
<td><strong>outp</strong></td>
<td>-1.192</td>
<td>-0.039</td>
<td>0.157</td>
</tr>
<tr>
<td></td>
<td>(0.932)</td>
<td>(0.900)</td>
<td>(0.771)</td>
</tr>
<tr>
<td><strong>mwr</strong></td>
<td>-2.786</td>
<td>-3.371</td>
<td>-1.634</td>
</tr>
<tr>
<td></td>
<td>(0.166)</td>
<td>(0.909)</td>
<td>(0.896)</td>
</tr>
</tbody>
</table>

### Stationarity in differences, t-values

<table>
<thead>
<tr>
<th>Variables</th>
<th>DF(1)</th>
<th>ADF(2)</th>
<th>ADF(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>empl</strong></td>
<td>-2.759</td>
<td>-4.125</td>
<td>-3.470</td>
</tr>
<tr>
<td></td>
<td>(0.360)</td>
<td>(0.673)</td>
<td>(0.921)</td>
</tr>
<tr>
<td><strong>prod</strong></td>
<td>-4.636</td>
<td>-3.445</td>
<td>-2.420</td>
</tr>
<tr>
<td></td>
<td>(0.440)</td>
<td>(0.467)</td>
<td>(0.430)</td>
</tr>
<tr>
<td><strong>outp</strong></td>
<td>-3.047</td>
<td>-3.170</td>
<td>-2.911</td>
</tr>
<tr>
<td></td>
<td>(0.963)</td>
<td>(0.854)</td>
<td>(0.675)</td>
</tr>
<tr>
<td><strong>mwr</strong></td>
<td>-4.274</td>
<td>-1.702</td>
<td>-1.797</td>
</tr>
<tr>
<td></td>
<td>(0.491)</td>
<td>(0.999)</td>
<td>(0.788)</td>
</tr>
</tbody>
</table>

Variables are the logarithm of: employment (empl), real hourly labour productivity (prod), real output (outp), real minimum wage (mwr).

DF: Dickey Fuller test.
ADF: Augmented Dickey Fuller test
AR coefficients are written in brackets after the DF and ADF values.
The significance level of the Ljung Box Q-statistic is written in brackets below the t-values.


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14 The critical values, using exactly the number of observations, were calculated following MACKINNON 1990, p. 14. Tables for critical values using a bigger number of observations may be found for instance in: ENGLE, YOO, 1987 p. 157.
The results imply that for all time series an unit root exists, but that differencing leads to stationarity.\textsuperscript{15} We see that using the 5 percent level employment, production and real minimum wage are $\text{I}(1)$. Output is $\text{I}(1)$ only if I use a 10 percent level. The important t-values are printed in italics. Summing up this results I have to differentiate all time series to achieve stationarity.

3.2. Co-integration of Time Series

A general definition of co-integration was given by ENGLE and GRANGER in 1987. First I remember the definition of integration given above: "A series with no deterministic component which has a stationary, invertible, ARMA representation after differencing d times, is said to be integrated of order d, denoted $y_t - \text{I}(d)$."\textsuperscript{16} Co-integration is defined as follows: "The components of a vector $x_t$ are co-integrated of order $d,b$, denoted $x_t - \text{CI}(d,b)$, if (i) all components of $x_t$ are $\text{I}(d)$; (ii) there exists a vector $\alpha(=0)$ so that: $z_t = \alpha'x_t - \text{I}(d-b)$, $b > 0$. The vector $\alpha$ is called the co-integrating vector."\textsuperscript{17}

In our case I only look at a special case. If the time series alone are $\text{I}(1)$ and the linear combination of the time series is $\text{I}(0)$, the time series are said to be co-integrated of order 1 (CI(1,1)).

\textit{Why test for co-integration?}

First, an economic interpretation of co-integration is possible. The "Granger-Representation Theorem" states that co-integrated time series can be represented as an error correction model.\textsuperscript{18} The economic idea of an error correction model in a two variable system is that there exists a long run equilibrium relationship between the two variables and that a deviation from this relationship is corrected in the following

\textsuperscript{15} For discussing the t-values I have to be sure, that the test statistic is valid, this means there exists no autocorrelation in the residuals. For our purpose I assumed that a 20 percent significance level of the Ljung Box Q-statistic is the boarder and within this boarder I had no problems with autocorrelation.

\textsuperscript{16} ENGLE, GRANGER 1987, p. 252.

\textsuperscript{17} ENGLE, GRANGER 1987, p. 253.

\textsuperscript{18} See exactly: ENGLE, GRANGER 1987, p. 255 ff.
periods. Hence co-integration may be interpreted as a stylised fact for a *long run* equilibrium relationship between two variables.

Second, testing for co-integration is necessary for the Granger-causality tests done later in this paper. For our purpose it is only possible to use the differenced time series (remember the results of chapter 3.1.). This gives rise to the probability that I discuss common properties of the differenced series even if there exist other common properties of the series in levels. If the time series are co-integrated, a pure VAR Model (which is the base of the Granger-causality tests done later) in differences of the variables will be misspecified. To correct, I would have to use an error correction term in the VAR's.

**Tests for co-integration**

In this paper I discuss bivariate cases. This means, I am only interested in the relationship between real minimum wage and one of the other variables alone.

In order to test for co-integration in the bivariate case I followed the "Engle-Granger Procedure". In a first step the parameters of the co-integrating vector are estimated by OLS. This regression is called the "co-integrating regression":

\[ y_{1t} = \text{const} + \alpha y_{2t} + \epsilon_t \quad t = 1 \ldots n \]

In a second step I use the residuals \( \epsilon_t \) of the co-integrating regression to test for co-integration using Dickey Fuller or augmented Dickey Fuller tests:

\[ \epsilon_t = \beta \epsilon_{t-1} + \mu_t \quad t = 1 \ldots n \]

In equation 7) the residuals \( \epsilon_t \) are the result from estimation of equation 6). Testing for co-integration now means testing for stationarity of \( \epsilon_t \). The null hypothesis of \( \beta = 1 \) corresponds to the null of "no co-integration" between \( y_{1t} \) and \( y_{2t} \). Some calculations and rearranging of the estimation equation leads to the above described

---

19 For the test procedure see: ENGLE, GRANGER 1987. This two-step estimator gives efficient parameters for the I(0) variables, but the estimates of the co-integration relations are not asymptotically efficient. This problem is discussed in ENGLE and YOO (1991). For an alternative method, using a maximum likelihood approach, see: JOHANSEN 1988 and JOHANSEN and JUSELIUS 1988.

20 \( \mu_t \) in this case describes the residuals.
DF and ADF tests. Therefore the null hypothesis now is $(\beta - 1) = 0$. Hence, in order to find no co-integration, the t-values have to be smaller than the critical values of the test statistics.

The results of the co-integrating regressions may be seen in the following table:

<table>
<thead>
<tr>
<th>Table 2: Co-integrating regressions (OLS)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>mwr</strong> = 32.768 $-$ 2.547 empl</td>
</tr>
<tr>
<td>(5.28) (5.46)</td>
</tr>
<tr>
<td><strong>empl</strong> = 10.043 $-$ 0.235 mwr</td>
</tr>
<tr>
<td>(268.16) (-5.46)</td>
</tr>
<tr>
<td><strong>mwr</strong> = 4.142 $+$ 0.841 prod</td>
</tr>
<tr>
<td>(13.03) (16.51)</td>
</tr>
<tr>
<td><strong>prod</strong> = -5.016 $+$ 1.108 mwr</td>
</tr>
<tr>
<td>(-66.17) (16.51)</td>
</tr>
<tr>
<td><strong>mwr</strong> = -8.784 $+$ 1.009 outp</td>
</tr>
<tr>
<td>(-22.42) (19.62)</td>
</tr>
<tr>
<td><strong>outp</strong> = 8.023 $+$ 0.874 mwr</td>
</tr>
<tr>
<td>(159.50) (19.62)</td>
</tr>
</tbody>
</table>

Variables are the logarithm of: employment (empl), real hourly labour productivity (prod), real output (outp), real minimum wage (mwr).

T-values are written in brackets below the coefficients.

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21 The tests are done corresponding to chapter 4.2.
The result of the DF and ADF tests are presented in the following table:

<table>
<thead>
<tr>
<th>Variables</th>
<th>DF(1)</th>
<th>ADF(2)</th>
<th>ADF(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>emp, mwr</td>
<td>-1.010</td>
<td>-1.559</td>
<td>-0.493</td>
</tr>
<tr>
<td></td>
<td>(0.412)</td>
<td>(0.743)</td>
<td>(0.390)</td>
</tr>
<tr>
<td>mwr, empl</td>
<td>-2.957</td>
<td>-2.394</td>
<td>-1.297</td>
</tr>
<tr>
<td></td>
<td>(0.421)</td>
<td>(0.776)</td>
<td>(0.439)</td>
</tr>
<tr>
<td>prod, mwr</td>
<td>-0.921</td>
<td>-0.496</td>
<td>-0.821</td>
</tr>
<tr>
<td></td>
<td>(0.696)</td>
<td>(0.849)</td>
<td>(0.460)</td>
</tr>
<tr>
<td>mwr, prod</td>
<td>-1.412</td>
<td>-1.091</td>
<td>-1.170</td>
</tr>
<tr>
<td></td>
<td>(0.649)</td>
<td>(0.769)</td>
<td>(0.494)</td>
</tr>
<tr>
<td>outp, mwr</td>
<td>-1.703</td>
<td>-1.540</td>
<td>-32.061</td>
</tr>
<tr>
<td></td>
<td>(0.900)</td>
<td>(0.995)</td>
<td>(0.927)</td>
</tr>
<tr>
<td>mwr, outp</td>
<td>-1.412</td>
<td>-1.091</td>
<td>-1.170</td>
</tr>
<tr>
<td></td>
<td>(0.649)</td>
<td>(0.770)</td>
<td>(0.494)</td>
</tr>
</tbody>
</table>

Variables are the logarithm of: employment (empl), real hourly labour productivity (prod), real output (outp), real minimum wage (mwr).

DF: Dickey Fuller test.
ADF: Augmented Dickey Fuller test
AR coefficients are written in brackets after the DF and ADF values.
The significance level of the Ljung Box Q-statistic is written in brackets below the t-values.

Critical values at the 10 percent level are for AR(1): -3.305, for AR(2): -3.289 and for AR(3): -3.27622

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22 Similar to table one, I calculated the critical values using exactly the number of observations following MACKINNON 1990, p. 14. The test statistics for the co-integration tests are different. Hence the calculated critical values are different. Tables for a bigger number of observations for co-integration tests may be found for instance in: ENGLE, YOO, 1987 p. 157.
All of the estimated t-values are smaller (or bigger in absolute values) than the according critical values at the five percent level. According to the table above in every case I find no co-integration.

This result is important in two different ways: First we may conclude that there exists no long-term equilibrium relationship between the attached variables. Second I do not have to care about an error correction term for the following Granger-causality tests. Hence I estimate pure VAR models.

4. Granger-causality tests

Broadly speaking, one variable $y_1$ Granger-causes an other variable $y_2$, if the knowledge of the past values of $y_1$ helps to reduce the mean square error of the forecasts of $y_2$.\(^{23}\)

A more formal definition may be the following:\(^{24}\) Suppose $\Omega_t$ contains really all relevant information up to period $t$. Define $\sigma^2(y_{1t}(1) \mid \Omega_t)$ to be the conditional mean square error of the optimal forecast of $y_{1t}(1)$ given all the information in $\Omega_t$. Denote all information in $\Omega_t$ that is not in $\{y_{2s} \mid s \leq t\}$ with: $\Omega_t \backslash \{y_{2s} \mid s \leq t\}$ Then the variable $y_2$ is Granger-caused by variable $y_1$ if for some $t$:

$$\sigma^2(y_{1t}(1) \mid \Omega_t) < \sigma^2(y_{1t}(1) \mid \Omega_t \backslash \{y_{2s} \mid s \leq t\})$$

The definition may be done similar for the other variable. A bivariate system, where $y_1$ Granger-causes $y_2$ and $y_2$ Granger-causes $y_1$ is called a feedback system.

\(^{23}\) For the definition of Granger-causality see: GRANGER 1969.

\(^{24}\) The definition follows JUDGE, HILL, GRIFFITHS, LÜTKEPOHL, LEE 1988, p. 768.
Tests for Granger-causality

In the former I am interested in testing for Granger-causality. Assume that vector $y_t = (y_{1t}, y_{2t})$ is driven by a bivariate VAR process which is stationary and normally distributed:

$$
\begin{bmatrix}
y_{1t} \\
y_{2t}
\end{bmatrix} =
\begin{bmatrix}
v_{1} \\
v_{2}
\end{bmatrix} +
\begin{bmatrix}
\theta_{11,1} & \theta_{12,1} \\
\theta_{21,1} & \theta_{22,1}
\end{bmatrix}
\begin{bmatrix}
y_{1t-1} \\
y_{2t-1}
\end{bmatrix} + \ldots +
\begin{bmatrix}
\theta_{11,p} & \theta_{12,p} \\
\theta_{21,p} & \theta_{22,p}
\end{bmatrix}
\begin{bmatrix}
y_{1t-p} \\
y_{2t-p}
\end{bmatrix} +
\begin{bmatrix}
v_{1t} \\
v_{2t}
\end{bmatrix}
$$

Assume additionally, that $y_t$ contains really all relevant information. Hence: $\Omega_t = \{y_s \mid s \leq t\}$. $y_1$ does not Granger-cause $y_2$ if and only if:

$$\theta_{12,1} = \theta_{12,2} = \ldots = \theta_{12,p} = 0$$

Hence testing for Granger-causality may be done by testing whether all $\theta_{12,i}$ (where $i = 1..p$) are significantly different from zero. This test is based on an F-test for OLS-estimation.

I have to find the number of the lags of the variables for the vector regression. The Schwartz criterion (SC) and the Akaische criterion (AIC) were used. In the following $N$ is the number of observations, $\Sigma$ is the variance-covariance matrix of the residuals and $K$ the number of parameters. Then the Schwartz criterion is defined as follows:

9) $SC = \ln \det \Sigma + K(\ln N)/N,$

and the Akaische criterion is defined as follows:

10) $AIC = \ln \det \Sigma + 2K/T$

---

25 For the test see for instance: JUDGE, HILL, GRIFFITHS, LÜTKEPOHL, LEE 1988, p. 768 f.
The decision rule is to use that model which minimises the above mentioned criterions. I used an upper bound of three periods.

The values of the two criterions are printed in the following table:

<table>
<thead>
<tr>
<th>Table 4: AIC and SC values for different lags</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC</td>
</tr>
<tr>
<td>---</td>
</tr>
<tr>
<td>mwr and empl</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td>mwr and outp</td>
</tr>
<tr>
<td></td>
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<tr>
<td></td>
</tr>
<tr>
<td>mwr and prod</td>
</tr>
<tr>
<td></td>
</tr>
<tr>
<td></td>
</tr>
</tbody>
</table>

Variables are the logarithm of: employment (empl), real hourly labour productivity (prod), real output (outp), real minimum wage (mwr).

The AR-lags are written in brackets.

The results of the SC and the AIC criterion are unique. In the following I used those models where the statistics are minimised, hence I estimated two lags for the minimum wage-employment relationship and one lag for the relationship between minimum wages and output and minimum wages and productivity.

Table 5 shows the results of the vector autoregressions.
Table 5: Bivariate vector autoregressions. Minimum wages and employment, minimum wages and output, minimum wages and productivity.

<table>
<thead>
<tr>
<th>Equation</th>
<th>Coefficients</th>
<th>t-values</th>
<th>R²</th>
</tr>
</thead>
<tbody>
<tr>
<td>(1) $\Delta \text{empt}_t$</td>
<td>$-0.01 + 0.68\Delta \text{empt}<em>{-1} - 0.64\Delta \text{empt}</em>{-2} + 0.16\Delta \text{mwrt}<em>{-1} - 0.05\Delta \text{mwrt}</em>{-1}$</td>
<td>(-1.42) (2.85) (-2.14) (1.55) (-0.74)</td>
<td>0.41</td>
</tr>
<tr>
<td>(2) $\Delta \text{mwrt}_t$</td>
<td>$0.02 - 0.77\Delta \text{mwrt}<em>{-1} - 0.53\Delta \text{mwrt}</em>{-2} - 0.38\Delta \text{empt}<em>{-1} + 0.62\Delta \text{empt}</em>{-2}$</td>
<td>(1.24) (-0.35) (2.37) (-0.38) (1.38)</td>
<td>0.33</td>
</tr>
<tr>
<td>(3) $\Delta \text{mwrt}_t$</td>
<td>$0.28 - 0.28\Delta \text{mwrt}<em>{-1} + 0.31\Delta \text{outp}</em>{-1}$</td>
<td>(1.54) (-0.12) (1.02)</td>
<td>0.06</td>
</tr>
<tr>
<td>(4) $\Delta \text{outp}_t$</td>
<td>$0.01 + 0.38\Delta \text{outp}<em>{-1} + 0.29\Delta \text{mwrt}</em>{-1}$</td>
<td>(1.19) (2.16) (2.21)</td>
<td>0.36</td>
</tr>
<tr>
<td>(5) $\Delta \text{mwrt}_t$</td>
<td>$0.01 - 0.04\Delta \text{mwrt}<em>{-1} + 0.60\Delta \text{prod}</em>{-1}$</td>
<td>(0.41) (-0.16) (1.09)</td>
<td>0.07</td>
</tr>
<tr>
<td>(6) $\Delta \text{prod}_t$</td>
<td>$0.04 - 0.09\Delta \text{prod}<em>{-1} + 0.17\Delta \text{mwrt}</em>{-1}$</td>
<td>(4.25) (-0.48) (2.10)</td>
<td>0.21</td>
</tr>
</tbody>
</table>

Variables are the logarithm of: employment (emp), real hourly labour productivity (prod), real output (outp), real minimum wage (mwrt).

T-values are written in brackets below the coefficients.
Equations 4) and 6) significantly state at the five percent level, that output and productivity depend positively on minimum wage. This seems to be a first indication for the argument of the labour union. A little bit confusing are the results of equation 1) and 2). The coefficients of the different lags show a different sign. I could not find an economic interpretation, but many of the coefficients are not significant. There exists the problem of significance with the remaining equations 3) and 5) too.

Results of Granger-causality tests:

The last table shows the results of the Granger-causality tests. It lists the p-values (the "marginal significance levels") for the null hypothesis, that the coefficient of the other variables is zero. mwr -> empl describes the effect of minimum wages on employment. empl -> mwr describes the effect of employment on minimum wages. The description for the other variables is similar.

<table>
<thead>
<tr>
<th>Table 6: Granger-causality tests: P-values</th>
</tr>
</thead>
<tbody>
<tr>
<td>mwr -&gt; empl</td>
</tr>
<tr>
<td>empl -&gt; mwr</td>
</tr>
<tr>
<td>mwr -&gt; outp</td>
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<tr>
<td>outp -&gt; mwr</td>
</tr>
<tr>
<td>mwr -&gt; prod</td>
</tr>
<tr>
<td>prod -&gt; mwr</td>
</tr>
</tbody>
</table>

Variables are the logarithm of: employment (empl), real hourly productivity (prod), real output (outp), real minimum wage (mwr).

Using a five percent significance level minimum wages neither Granger-cause employment nor employment Granger-causes minimum wages. I find only two cases, where the null hypothesis of no Granger-causality has to be rejected. Real minimum wages Granger-cause output and they Granger-cause labour productivity. Additionally, looking at the according bivariate vector autoregressions in table five, namely equation four and six, there should be a significant positive effect on output.
and productivity. The causal relationship does not, as expected from "standard" economic theory, work in the other direction!

These results are important for the discussion of the effects of minimum wages:

First, I found no significant negative effect of minimum wages on employment. This result is in strong contrast to the results of the "traditional" regression analysis.\textsuperscript{26}

Second, minimum wage, and both output and productivity seem not to be independent. This stylised fact gives rise that studies about minimum wages, where employment (estimated by OLS) is a function of productivity and minimum wage, may be misspecified.\textsuperscript{27}

Third, following the argument of the labour union, if there really exists a positive effect of minimum wages on output and productivity, this positive effect is not strong enough to have any impact on employment.

Minimum wages are implemented to change the income distribution. The central argument against them is their supposed negative effect on employment. The fourth point deals with this employment effect: The results of this paper could lead to a reduction of the importance of the employment argument concerning minimum wages in the Austrian case. Here I mean both, positive and negative effects.

5. Summary

In spite of the "standard" neo-classical theoretical result (minimum wages should decrease employment), there exist arguments of the Austrian labour union for the implementation of minimum wages. One of these arguments states that minimum wages should have a positive long term effect on economic growth and productivity and therefore maybe even on employment.

In this paper I analyse the relationship between employment, productivity, minimum wage and output for the Austrian case. I try to prepare stylised facts and for this

\textsuperscript{26} RAGACS 1993.

\textsuperscript{27} Compare: RAGACS 1993. The used variables of this study are not complete identical: The variables of the regression analysis were: The level of logarithmic real minimum wage, the growth rate of hourly output and the level of lagged hourly labour productivity.
purpose I use methods coming from time series analysis, namely the concepts of co-integration and of Granger-causality.

Testing for co-integration found no co-integration between minimum wages and employment and hence no long term equilibrium relationship between the two variables. The result of the Granger-causality tests is that I found two cases in which the null hypothesis of no Granger-causality has to be rejected. Real minimum wages Granger-cause output and they Granger-cause labour productivity. Hence we find stylised facts which at the first sight would help to strengthen the argument of the labour union. But even if there exist positive impacts of minimum wages on productivity and output, the effects are too weak to have a positive effect on employment.

Analysing Granger-causality between employment and minimum wages found no causality, neither positive nor negative. This is in contrast to the empirical results of the "traditional" regression analysis done in working paper No. 20 of the Viennese University of Economics and Business Administration\textsuperscript{28} as well as to most empirical studies done for the same subject, but for other countries.

\textsuperscript{28} RAGACS 1993.
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