

The Relationship between Macroeconomics and Outbound Tourism –Evidence from Taiwan

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ABSTRACT

This article discusses the short-term and long-term effects that the industrial production index, consumer price index and foreign exchange rate have on the person-times of outbound travelers in the travel model. This research was undertaken using the Johansen's cointegration test methodology to analyze the data. In addition, this research also employs the Impulse Response Function to analyze the impact of cross-period dynamic between variables. The findings of this research show that aside from a significant short-term transitory impact, the industrial production index also causes a transitory impact on the person-times of outbound travelers in the long-term.

Keywords: *person-time of outbound travelers, macroeconomic variables, Impulse Response Function*

FOREWORD

In recent years, there has been much literature discussing the interaction between tourism and macroeconomic variables. Literature focusing on research into the relationship between the exchange rate and tourism include Lorde (1995), who found during the forecast of demand in the Caribbean that the weighted average exchange index is the main factor influencing the number of inbound tourism in that area, while Kanta (1999) targeted research in Canada, investigating the trilateral relationship when comparing the Canadian dollar to the US dollar, British sterling, and Japanese yen. This research showed that the influence of British sterling and Japanese yen on the Canadian dollar was more pronounced while that of the US dollar was less significant. Furthermore, Shachmurove (1999) analyzed the influence that the black market and official exchange markets have on tourism. Matteo (1999) discussed the influence that exchange rates have on Canadian travelers by car to the United States, while Coshall (2000) used time series analysis to research the potential influence that exchange rates, between British sterling, the US dollar and French francs, have on the expenditures of British travelers. There is also research on the relationship between consumer price and tourism. Martin and Cooper (1999) analyzed the impact that New Zealand airline ticket prices have on the airline industry. Lindberg and Aylward (1999) discussed the relationship between price elasticity, commodity prices and tourism in 3 national parks in Costa Rica. Research on this topic also includes Papatheodorou (1999), Kashyap and Bojanic (2000), and Goodrich (2001). Research on the relationship between income levels and tourism include Agarwal and Yochum (1999); Crompton, Lee and Shuster (2001) that targeted tourist attractions in the United States; and Baaijens and Nijkamp (2000) which focused on the regional viewpoint of the Greek islands. For research on the relationship between a particular country's income level and tourism, there is Greg (1999), who compared European countries, the United States and Japan; Victurine (2000) focused on Uganda; Goldstein (2001) researched the African country Western Sahara; and, Strizzi and Meis (2001) who targeted Latin American countries and the Caribbean, LAC. Furthermore, there is research that combines several macroeconomic variables in their analysis of tourism. Quayson and Var (1985) used the travel demand model to estimate the tourism demand of New York City. They found that the income level of local travelers in New York City were less elastic and sensitive, while Canadian travelers were extremely sensitive even to very small changes in the exchange rate between the US dollar and Canadian dollar.

This research targets outbound travelers from Taiwan. Breaking away from single variable impact, the research discusses the influences that Taiwan's industrial production index, consumer price index and exchange rate fluctuation have on the number of outbound travelers. The result of this research will be provided to the tourism industry and tourism related government agencies for reference. In order to discuss the long-term and short-term interactions of

different variables, this research fully combined many time series analyses that were developed in recent years, including:

1. Johansen's VAR Model (1988,1990, &1994), which incorporates the cointegration test to determine if these variables have a long-term balancing relationship. The unit-root test was also incorporated to take account of the variable's stationarity as a prerequisite for the cointegration test (this article will adopt the ADF unit-root test from Dickey & Fuller (1981)).
2. Granger (1988)'s ECM Model to perform the Granger Causality test on short-term interaction.
3. Generalized Impulse Response Function to evaluate the cross-period dynamic effect of 4 variables.
4. The use of Variance Decomposition to determine the exogeneity ordering of these variables. The purpose of combining these time series analyses is to perform in-depth research on the interaction between these variables in the short-term, and the impact on the long-term equilibrium, impact and changes.

Methodology and Empirical Results

Using the travel industry of Taiwan as evidence, this paper investigates the dynamic relationship among the number of outbound tourists and three macroeconomic fundamentals, namely industrial production, the consumer price index, and the exchange rate. The travel model can be formulated as:

$$TRO = f(IP, CPI, EX) \quad (1)$$

where TRO represents the number of outbound tourists. IP, CPI, and EX are the symbols for industrial production, the consumer price index, and the exchange rate.

However, for the long-term co-movement, TRO together with IP, CPI, and EX formulate a mutually endogenous VAR model.

$$X_t = \Pi_0 + \Pi_1 X_{t-1} + \Pi_2 X_{t-2} + \dots + \Pi_p X_{t-p} + \mu_t \quad (2)$$

where X is a 4×1 vector, which includes the variables of TRO, IP, CPI, and EX. Π_0 is a 4×1 vector of intercept. Π_i is a 4×4 coefficient matrix. μ_t is a 4×1 vector of error term.

In order to avoid the "spurious regression" problem and to fully investigate the long-term equilibrium and short-term dynamic relationship between the variables of our travel model, various time series methodologies are employed in this study, which includes Johansen (1988 and 1994) and Johansen and Juselius's (1990) five VAR model cointegration (CI) tests for testing the long run equilibrium relationship, Granger's (1969) Granger causality (GC) test for testing for the lead-lag relationship, the generalized-impulse response function (G-IRF) to evaluate the interactive impulse effect, and variance decomposition (VDC) to investigate the relative exogeneity.

Unit Roots:

According to Schwert (1989) and Ayat and Burrige (2000), this paper employs ADF test to test for the "stationarity" of each variable of our travel model. The ADF's three models are expressed as the following forms:

$$\Delta y_t = \phi y_{t-1} + \sum_{i=2}^p \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (3)$$

$$\Delta y_t = \alpha + \phi y_{t-1} + \sum_{i=2}^p \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (4)$$

$$\Delta y_t = \alpha + \gamma t + \phi y_{t-1} + \sum_{i=2}^p \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (5)$$

Equation (3) is a pure random walk with the lag terms. Equation (4) possesses a drift. Equation (5) includes a drift and a time trend. The null hypothesis for the ADF test is: $H_0: \phi = 0$, with the alternative $H_1: -2 < \phi < 0$.

Elder and Kennedy (2001) argued that a strategy is necessary to determine which of the three ADF models should be employed in conducting the unit root test. In this paper, we follow the determining rule of Doldado, Jenkinson, and Sosvilla-Rivero (DJS) (1990) to determine the appropriate model for each rate. Moreover, since the estimation might be biased if the lag length is pre-designated without rigorous determination, this paper adopts the Schwartz Bayesian information criterion (SBC) to select the optimal number of lags based on the "principle of parsimony".

Table 1 presents the results of the ADF tests that each variable has its unit-root in the level and is rejected to be “non-stationary” in the first difference. This ensures the I(1) type series for all four variables are considered in our travel model.

Table 1: The results of ADF unit-root tests (period 1980/1-2002/10)

	Level			First difference		
	$\tau(0)$	$\tau_{\mu}(0)$	$\tau_{\tau}(0)$	$\tau(1)$	$\tau_{\mu}(1)$	$\tau_{\tau}(1)$
IP	2.530[14]	-0.196[14]	-2.295[11]	-26.899[0] ***	-26.953[0]***	-26.903[0]***
EX	-0.280[7]	-1.546[7]	-1.295[7]	-3.455[7] **	-3.448[7]**	-3.532[7]**
CPI	2.455[14]	-0.185[14]	-1.965[3]	-4.462[13]***	-18.320[0] ***	-18.422[0]***
TRO	2.033[15]	0.230[15]	-2.473[14]	-22.084[0] ***	-22.084[0]***	-22.043[0]***

- notes: 1. IP, EX, CPI, and TRO represent industrial production, exchange rate, consumer price index, and outbound tourism, respectively.
 2. The symbol ***, **, and *, represent the significant at 1%, 5%, and 10% levels, respectively.
 3. $\tau(0)$, $\tau_{\mu}(0)$, and $\tau_{\tau}(0)$ are the test statistics for a unit root in the level without constant, with constant, and with both constant and trend, respectively.
 4. $\tau(1)$, $\tau_{\mu}(1)$, and $\tau_{\tau}(1)$ are the test statistics for a unit root in the difference without constant, with constant, and with both constant and trend, respectively.
 5. The critical values (-3.9935; -3.4271; -3.1368) for the ADF t-statistics are from the MacKinnon (1996) table.
 6. The bold numbers indicate the appropriate model of ADF determined by DJS (1990).
 7. The numbers within the square bracket are the appropriate lag lengths for each variable based on MAIC.

Cointegration

Various methods of estimating cointegration have been applied to capture the long-term equilibrium relationship between the variables. Among these, Johansen’s methodology, based on the likelihood ratio with non-standard asymptotic distributions involving integrals of Brownian motion, is found to be the best method to proceed with cointegration estimation by Gonzalo (1994). (1)

The elaborate works developed by Johansen (1988) and further extended by Johansen and Juselius (1990) and Johansen (1994) are summarized into five VAR models with ECM, which are presented in the following forms:

$$1988: H_0(r): \Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha \beta' X_{t-1} + \psi D_t + \varepsilon_t \quad (6)$$

$$1990: H_1^*(r): \Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha(\beta', \beta_0)(X_{t-1}, 1)' + \psi D_t + \varepsilon_t \quad (7)$$

$$1990: H_1(r): \Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha \beta' X_{t-1} + \mu_0 + \psi D_t + \varepsilon_t \quad (8)$$

$$1994: H_2^*(r): \Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha(\beta', \beta_1)(X_{t-1}, t)' + \mu_0 + \psi D_t + \varepsilon_t \quad (9)$$

$$1994: H_2(r): \Delta X_t = \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-k+1} + \alpha \beta' X_{t-1} + \mu_0 + \mu_1 t + \psi D_t + \varepsilon_t \quad (10)$$

Johansen (1994) emphasized the role of the deterministic term, $Y = \mu_0 + \mu_1 t$, which includes constant and linear terms in the Gaussian VAR. Following Nieh and Lee’s (2001) decision procedure among the hypotheses $H(r)$ and $H^*(r)$ for five different models, the appropriate cointegration relationship can be found in the presence of linear trend and quadratic trend. (2)

When testing for four-variable VAR, the first model with two cointegration ranks is found (see Table 2). This implies that TRO co-moves with our three presumed macroeconomic fundamentals in the long run. This long-term equilibrium relationship between the variables demonstrates a pure co-movement presenting neither linear trend nor quadratic trend.

Table 2: Determination of Cointegration rank in the Presence of a Linear Trend and a Quadratic Trend

Rank	Model 1		Model 2		Model 3		Model 4		Model 5	
	$H_0(5)$	$H_0(5)$	$H_1^*(5)$	$H_1^*(5)$	$H_1(5)$	$H_1(5)$	$H_2^*(5)$	$H_2^*(5)$	$H_2(5)$	$H_2(5)$
$r = 0$	100.19	39.89	156.27	53.12	138.18	47.21	186.37	62.99	182.81	54.64
$r \leq 1$	27.28	24.31	53.28	34.91	40.35	29.68	81.99	42.44	78.53	34.55
$r \leq 2$	9.48	12.53	19.54	19.96	8.44	15.41	21.58	25.32	18.34	18.17
$r \leq 3$	2.28	3.84	2.33	9.24	2.12	3.76	3.81	12.25	3.81	3.74

- notes: 1. $T_0(r)$, $T_1^*(r)$, $T_1(r)$, $T_2^*(r)$, and $T_2(r)$ denote the LR test statistics for all the null of $H(r)$ versus the alternative of $H(p)$ of Johansen’s five models.

2. $C_0(5\%)$, $C_1^*(5\%)$, $C_1(5\%)$, $C_2^*(5\%)$ and $C_2(5\%)$ are 5% LR critical values for Johansen's five models, which are extracted from Osterwald-Lenum (1992).
3. The model selection follows Nieh and Lee's (2001) decision procedure, diagnosing models one by one until the model that cannot be rejected for the null.
4. The bold number with underline indicates the selection of the rank in the presence of linear trend and quadratic trend.
5. VAR length selected based on the smallest number of SBC is 5 for all the models, as indicated in the parenthesis.

Since the purpose of this study is to find the degree of influence of each macroeconomic fundamental over the TRO, we further test for the pairwise cointegration relationship between each of the presumed macroeconomic variables and the TRO. From Table-3, we observe that CPI is the only variable found to share the long-run equilibrium relationship with the TRO of Taiwan. The price level in Taiwan seems the most influential variable as an indicator to predict the long-term outbound tourism movement. However, analyzing the short-term impacts of the cointegration equations, we find that all three coefficients are shown to be significant. The t-values are 9.76, 3.29, and 6.35 respectively, for the impacts of industrial production, exchange rate and consumer price index on the TRO. However, all the influences are shown to be negative, which implies that the decrease in the level of industrial production, the appreciation of the Taiwan dollar, and the fall of the consumer price index will increase the TRO.

Table 3: Cointegration test between outbound tourism and each of macroeconomic variables

TRO and IP [1]: Cointegration equation: $TRO_t = -4106.12IP_t + \varepsilon_t$ (420.84)										
Rank	$T_0(r)$	C_0	$T_1^*(r)$	C_1^*	$T_1(r)$	C_1	$T_2^*(r)$	C_2^*	$T_2(r)$	C_2
$r = 0$	<u>12.29</u>	12.53	59.30	19.96	56.80	15.41	112.65	25.32	112.65	18.17
$r \leq 1$	1.22	3.84	3.19	9.24	0.85	3.76	34.60	12.25	34.60	3.74

TRO and EX [1]: Cointegration equation: $TRO_t = -10270.58EX_t + \varepsilon_t$ (3120.45)										
Rank	$T_0(r)$	C_0	$T_1^*(r)$	C_1^*	$T_1(r)$	C_1	$T_2^*(r)$	C_2^*	$T_2(r)$	C_2
$r = 0$	<u>5.91</u>	12.53	9.65	19.96	9.00	15.41	49.50	25.32	47.79	18.17
$r \leq 1$	0.20	3.84	1.58	9.24	1.39	3.76	1.88	12.25	0.46	3.74

TRO and CPI [1]: Cointegration equation: $TRO_t = -8184.04CPI_t + \varepsilon_t$ (1289.16)										
Rank	$T_0(r)$	C_0	$T_1^*(r)$	C_1^*	$T_1(r)$	C_1	$T_2^*(r)$	C_2^*	$T_2(r)$	C_2
$r = 0$	17.34	12.53	81.99	19.96	66.88	15.41	77.27	25.32	75.05	18.17
$r \leq 1$	<u>3.24</u>	3.84	12.21	9.24	2.29	3.76	5.84	12.25	4.50	3.74

- notes: 1. IP, EX, CPI, and TRO represent industrial production, exchange rate, consumer price index, and outbound tourism, respectively.
2. $T_0(r)$, $T_1^*(r)$, $T_1(r)$, $T_2^*(r)$, and $T_2(r)$ denote the LR test statistics for all the null of $H(r)$ versus the alternative of $H(p)$ of Johansen's five models.
 3. $C_0(5\%)$, $C_1^*(5\%)$, $C_1(5\%)$, $C_2^*(5\%)$ and $C_2(5\%)$ are 5% LR critical values for Johansen's five models, which are extracted from Osterwald-Lenum (1992).
 4. The model selection follows Nieh and Lee's (2001) decision procedure, diagnosing models one by one until the model that cannot be rejected for the null.
 5. The bold number with underline indicates the selection of the rank in the presence of linear trend and quadratic trend.
 6. VAR length selected based on the smallest number of SBC is 1 for all the models, as indicated in the square bracket.

Granger Causality

To test the lead-lag relationship between pairwise variables, Granger (1969) developed an influential technique, called the Granger causality test. Considering two series, A_t and B_t , the models explained in the form of Granger (1969) are as follows:

$$A_t = c + \sum_{i=1}^k \alpha_{1i} A_{t-i} + \sum_{i=1}^k \beta_{1i} B_{t-i} + \mu_{at} \quad (11)$$

$$B_t = c + \sum_{i=1}^k \alpha_{2i} B_{t-i} + \sum_{i=1}^k \beta_{2i} A_{t-i} + \mu_{bt} \quad (12)$$

where k is the lag length and is selected by SBC in this study. The null is that the series B_t fails to Granger cause A_t if $\beta_{1i} = 0$ ($i=1,2,3,\dots,k$) and the series A_t fails to cause B_t if $\beta_{2i} = 0$.

Table 4: Pairwise Granger causality test

Null Hypothesis	F-Statistic	Probability
IP does not Granger Cause TRO	56.4255***	0.00000
TRO does not Granger Cause IP	83.5322***	0.00000
EX does not Granger Cause TRO	2.63582	0.10564
TRO does not Granger Cause EX	9.80784***	0.00193
CPI does not Granger Cause TRO	41.4989***	0.00000
TRO does not Granger Cause CPI	17.5227***	0.00004
EX does not Granger Cause IP	1.16729	0.28092
IP does not Granger Cause EX	1.95388	0.16332
CPI does not Granger Cause IP	57.0979***	0.00000
IP does not Granger Cause CPI	20.3130***	0.00000
CPI does not Granger Cause EX	7.33982***	0.00718
EX does not Granger Cause CPI	3.79187*	0.05254

notes: 1. TRO, IP, EX and CPI are the symbols for outbound tourist, industrial production, exchange rate and consumer price index, respectively.

2. The symbol ***, **, and *, represent the significant at 1%, 5%, and 10% levels, respectively.

3. The null hypothesis, H_0 , is for "no causal relation".

4. Lag length is 1 selected by SBC.

Table 4 represents the results of the GC test for our outbound tourism relationship. As shown, the exchange rate is the only factor which does not lead the trend of the TRO, whereas industrial production and consumer price index both show strong feedback relationships with the TRO.

Variance Decomposition and Generalized-Impulse Response Function

Following Sims (1980, 1986) and Hamilton (1994), the reduced form of the structure VAR model: $Bx_t = \Gamma_0 + \Gamma_1 x_{t-1} + \varepsilon_t$, can be transformed to a four-dimensional standard form: $x_t = A_0 + A_1 x_{t-1} + e_t$, where Γ_0 and $A_0 = B^{-1}\Gamma_0$ are a 4×1 vector of constants; Γ_1 , $A_1 = B^{-1}\Gamma_1$ and the back operator B are 4×4 matrices; the white-noise, ε_t , and the disturbance $e_t = B^{-1}\varepsilon_t$ are 4×1 vectors.

For further derivation, we obtain a vector moving average (VMA) representation:

$$x_t = \mu + \sum_{i=0}^{\infty} A_1^i e_{t-i} \quad [\text{i.e., } x_t = (I + A_1 + \dots + A_1^n)A_0 + \sum_{i=0}^n A_1^i e_{t-i} + A_1^{n+1}x_{t-n-1}]$$

In order to transfer the model to be expressed in the form of white-noise disturbance, we finally reach the form as the following expression:

$$x_t = \mu + \sum_{i=0}^{\infty} \phi_{jk}(i) \varepsilon_{t-i} \quad (13)$$

where μ is a 4×1 vector of constants and elements of $\phi_{jk}(i)$, a 4×4 matrix with $\phi_{jk}(0) = I_4$, are the "impact multipliers", which examine the interaction over the entire path of volatility, export, import and productivity sequences. Equation (13) is the so-called impulse response function.

If the disturbance at all lags, ε_{t-i} , are absolutely and contemporaneously uncorrelated, we can easily find the percentage of the FEV that occurs in the VAR, and then judge the relative exogeneity of all the presumed endogenous variables. However, it is not always the case. Researchers thus applied Choleski decomposition (i.e., multiply the disturbance term, ε_{t-i} by a 4×4 lower triangular matrix V, where $VV' = I_4$) to construct a VMA representation with a disturbance process that is orthogonal contemporaneously at all lags.

Assume the VMA representation: $x_t = \alpha' + \sum_{i=0}^{\infty} C_i \varepsilon_{t-i}$, where C_i is a 4×4 matrix with $C_0 = I_4$. The transformation of this VMA in terms of orthogonal innovations at all lags is given by

$$x_t = \alpha' + \sum_{i=0}^{\infty} C_i V V' \varepsilon_{t-i} = \alpha' + \sum_{i=0}^{\infty} D_i \mu_{t-i} \quad (14)$$

where $D_i = C_i V$ and $\mu_{t-i} = V' \varepsilon_{t-i}$.

From the equation (14), the k-step ahead forecast error of x_t is given by:

$$x_t - \hat{E}_{t-k} x_t = D_0 \mu_t + D_1 \mu_{t-1} + \dots + D_{k-1} \mu_{t-k+1} \quad (15)$$

where $\hat{E}_{t-k} x_t = D[x_t | x_{t-k}, x_{t-k-1}, x_{t-k-2}, \dots]$, implies that utilizing all the information set at period t-k to forecast the present value of x_t . The corresponding variance-covariance matrix of this k-step ahead of forecast error is expressed as follows:

$$E\left(x_t - \hat{E}_{t-k} x_t\right)\left(x_t - \hat{E}_{t-k} x_t\right)' = D_0 E(\mu_t \mu_t') D_0' + D_1 E(\mu_t \mu_t') D_1' + \dots + D_{k-1} E(\mu_t \mu_t') D_{k-1}' \quad (16)$$

As King et al. (1991) and Zhou (1996) point out that as there are more than one common trends in a model, different ordering of variables may significantly affect the results of IRF and VDC if the common trends are not absolutely uncorrelated. In this paper, the relative exogeneity of our four variables is ordered, from the above GC test, as the consumer price index, TRO, industrial production and exchange rate (i.e., CPI \rightarrow TRO \rightarrow IP \rightarrow EX). Since the technique of variance decomposition (VDC) decomposes the forecast error variance (FEV), which in turn offers information about the relative importance of each random innovation to the variables. We, based on the presumed exogeneity ordering, further investigate the forecast error variance decomposition of our outbound tourism model.

CONCLUSION

This study, using Taiwan's travel industry as evidence, aims at determining the factors which affect the number of outbound tourists of Taiwan. We first find that a long-run equilibrium relationship exists among the numbers of outbound tourists and three presumed macroeconomic fundamentals, namely IP, CPI, and ER. However, CPI is the only variable found to share the long-term equilibrium relationship with the outbound tourism of Taiwan when dual testing is used. Analyzing the short-run impact of the cointegration equation, we find that all three fundamentals are shown to affect the TRO significantly and negatively, which implies that economic growth, inflation and currency depression will all reduce the TRO. Further testing of the Granger causality finds feedback relationships between the TRO and each of IP and CPI, but not the EX. The forecast error variance of each variable is mostly self-explained and not explained by other variables. However, in explaining the forecast error variance of the TRO, IP turns out to be the only factor which shows moderate explaining power in the long-run.

The generalized-impulse response function reveals that, in the short run, the number of outbound tourists is not only self-responded, but also responded transitorily and negatively to the shock of industrial production. However, the responses of the number of outbound tourists to shocks of all macroeconomic fundamentals are diminished in the long run. It can be concluded that there is no permanent impact of innovations of macroeconomic fundamentals on the number of outbound tourists.

NOTES

- (1) Gonzalo (1994) compared several methods of estimating cointegration, which include ordinary least squares, nonlinear least squares, the maximum likelihood in an error correction model, principle components, and canonical correlations.

- (2) Nieh and Lee's (2001) decision procedure is indeed an application of testing procedure developed by Johansen (1992, 1994) based on the ideas of Pantula's (1989) nest and non-nest hypothesis to determine the number of cointegrating rank in the presence of linear trend [Johansen (1992)] and quadratic trend [Johansen (1994)]. The decision procedure is organized in the following way: $H_0(0) \rightarrow H_1^*(0) \rightarrow H_1(0) \rightarrow H_2^*(0) \rightarrow H_2(0) \rightarrow H_0(1) \rightarrow H_1^*(1) \rightarrow H_1(1) \rightarrow H_2^*(1) \rightarrow H_2(1) \rightarrow \dots \rightarrow \dots \rightarrow H_0(p-1) \rightarrow H_1^*(p-1) \rightarrow H_1(p-1) \rightarrow H_2^*(p-1) \rightarrow H_2(p-1)$

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