

# How is the dynamic impact of Undervaluation on Economic Growth in Latin American Countries?: A Panel VAR analysis

CESAR CHAVEZ (✉ [carlos.chavez2@unmsm.edu.pe](mailto:carlos.chavez2@unmsm.edu.pe))

---

## Research

**Keywords:** Real Exchange Rate, Undervaluation, Panel VAR, Developing Countries

**Posted Date:** April 30th, 2020

**DOI:** <https://doi.org/10.21203/rs.3.rs-25367/v1>

**License:** © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License.

[Read Full License](#)

---

How is the dynamic impact of Undervaluation on Economic Growth in Latin American Countries?: A Panel VAR analysis

Cesar Chavez\*

Abstract

In this research, I analyze the dynamic effects of undervaluation on the economic growth per capita of Latin American countries with a period 1980-2018. To estimate these effects, I use a Panel Vector Autoregressive (PVAR) whose estimator is System GMM. The undervaluation variable is created from different measures of the real exchange rate and I also use various measures of GDP per capita to calculate economic growth per capita. I include as control variables macroeconomic and human capital variables to control the different channels of spread of undervaluation on economic growth per capita. The results show that there is a positive effect depending on the definition of the real exchange rate used to calculate the undervaluation. In the results I include the Granger causality test, stability test and impulse response graphs in which I project the response of per capita economic growth to an undervaluation shock.

JEL codes: F14, F47, C33, C53,

Keywords: Real Exchange Rate, Undervaluation, Panel VAR, Developing Countries

---

\* Corresponding author  
Faculty of Economics Sciences  
National University of San Marcos  
E-mail address: [carlos.chavez2@unmsm.edu.pe](mailto:carlos.chavez2@unmsm.edu.pe)

## 1. Introduction:

There has been extensive debate in the macroeconomic literature about currency devaluation policies to expand the economy. For Asian countries, evidence is found that these policies were fundamental for their rapid economic growth, see Cottani, et al. (1990). Morrison and Labonte (2013) study these policies for the case of China. The theory behind this suggests that a devalued currency may serve to protect newly emerging companies, because it allows them to be more competitive in the world market, but may have negative effects on GDP, see Krugman and Taylor (1978). That is why an interest in studying the imbalances of the real exchange rate has arisen. However, these policies have their detractors, such as Williamson (1990), who points out that an undervaluation policy can produce unnecessary inflationary prices, damaging other productive sectors. Balassa (1982) points out that a devaluation can be interpreted as imposing tariffs and subsidizing exports. Empirical evidence finds scattered results about these impacts on economic growth. Yang et al. (2013) elaborates a global general equilibrium model to estimate the macroeconomic impacts of the appreciation of the Chinese currency in that country and the world, finding that appreciations of this currency can have positive effects on the GDP of the main countries with which it trades. In Latin America there have been some studies investigating the impact of exchange rate devaluations, for example, Mejía-Reyes, et al. (2010) studies the effects of changes in the exchange rate on GDP for five Latin American countries, dividing them into two groups, non-oil and oil countries, finding that for non-oil countries there are negative effects of a depreciation in the short term. Lamau (2017) studies the effects of depreciations of the real exchange rate on growth across sectors in Latin America, finding that a shock of 10% depreciation can increase growth in non-traditional sectors by 0.6 to 2% depending on the channel of transmission. Along this same line, Galindo et al. (2006) studies the effects of the depreciation of the real exchange rate on industrial sectors in Latin America, finding that there are positive effects except for industries with high industrialization. Globally, Kappler et al. (2011) studies the effects of an appreciation of the real exchange rate for a sample of 128 countries found that there are no significant effects on economic growth. Habib et al. (2017) studies the effects of a depreciation of the real exchange rate on growth for 150 countries after the Bretton Woods period, finding that a real appreciation significantly reduces real economic growth. Christopoulos (2004) studies the effects of a currency devaluation on economic growth using a cointegration test, finding insignificant results. As can be seen, there is a key importance in studying the movements of the real exchange rate, and the effects found by various studies are varied depending on the sample size and the methodology used. Our research contributes to the economic evidence in this field because we study the effects of undervaluation on economic growth per capita, but we use various measures to estimate undervaluation using various measures for undervaluation and also for GDP per capita that is used to calculate the economic growth per capita. The methodology that we use is also relatively new that serves to estimate dynamic impacts called the VAR Panel, proposed by Love and Zicchino (2006). The results we find depend on the undervaluation measure we use. If we use the third undervaluation measure, we find positive impacts that, over the time horizon, end up being offset while the first two measures have different effects. This research is presented as follows: Section 02 presents the literature review of studies estimating the effects of undervaluation on economic growth. Section 03 develops how we build our real exchange rate measures with which we estimate the undervaluation, we also develop ways to calculate GDP per capita that will serve to calculate economic growth per capita and, finally, we present our methodology to use to make the estimates, and in section 04 we show the conclusions found in this study. We also added the annexes where other tests developed in our research are shown, the definitions of the variables and their sources, and the countries we used in this study.

## 2. Literature Review:

The term undervaluation means that the price of a good in one country is low compared to the price of other countries, which can be the dollar, see Contractor (2019). Another definition is found in Guzmán, et al. (2012) who point out that they are deviations from a standard income





GDP per capita_1	-0.61*** (-9.31)	0.87*** (4.51)	0.23** (3.03)
N	418	418	418
Adj. Rsquared	0.204	-0.004	0.703
Real Exchange Rate: Second GDP Measure			
	(1)	(2)	(3)
GDP per capita_2	-0.78*** (-8.24)	0.23 (2.48)	-0.32*** (-4.04)
N	418	418	418
Adj. Rsquared	0.161	-0.012	0.709
Real Exchange Rate: Third GDP Measure			
GDP per capita_3	-0.65*** (-5.70)	-0.50*** (-4.33)	-0.50*** (-12.88)
N	418	418	418
adj. R-sq	0.332	-0.008	0.790

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

All estimates have been made with robust standard errors. Each column represents an estimate for each real exchange rate variable. And each row shows us the results for each measure of GDP per capita.

The results show us that the first definition of the real exchange rate finds positive coefficients for all the definitions of GDP per capita. The second definition of the real exchange rate has a poor adjustment and is positive in two of the three regressions with the different GDP per capita. The third definition of the real exchange rate is positive only in the first definition of economic growth and is the one with the greatest adjustment. Then, once our regressions are estimated, we calculate the undervaluation from the difference of the current real exchange rate with the real exchange rate predicted by our model, and it is presented in equation (6);

$$\ln Underval_{i,t} = \ln RER_{i,t} - \ln \overline{RER}_{i,t}. \quad (6)$$

Where  $\ln \overline{RER}_{i,t}$  is the predicted value of equation (5). The interpretation of these undervaluation variables is presented as follows: If  $Underval_{i,t}$  is greater than unity, it indicates that the exchange rate of country i is cheaper in dollar terms compared to other countries, then the local currency is said to be undervalued. Otherwise, that is, in case  $Underval_{i,t}$  is less than unity, the currency is overvalued. And if it is equal to unity, it is in equilibrium. So, now we turn to present our methodology that we will use to estimate the effects of undervaluation on economic growth.

### 3.2 Second Stage: Estimating the dynamics effects:

Our empirical methodology that we use is based on the previous work of Love and Zicchino (2006), who use this methodology to estimate the dynamic effects of investments on financial development. They use an Autoregressive Panel Vector (PVAR) that has the form of equation (7):

$$Y_{i,t} = A \sum_{p=1}^2 Y_{t-p} + u_{i,t} + e_{i,t}. \quad (7)$$

Where  $Y_{i,t}$  is a  $vector_{1 \times k}$  of dependent variables such as  $[Economic\ Growth_{i,t}, GDP\ per\ capita_{i,t}, Underval_{i,t}]^2$ ,  $u_{i,t}$  is the  $vector_{1 \times k}$  that contains the fixed and specific invariant effects over time of the dependent variable,  $e_{i,t}$  is the term error or idiosyncratic error and finally A is the coefficient matrix of the impacts of the lagged values of the endogenous variables. In this estimation it is assumed that the idiosyncratic error is presented as follows:  $E[e_{i,t}] = 0, E[e'_{i,t}e_{i,t}] = \Sigma$  y  $E[e'_{i,t}e_{i,s}] = 0$ , for all  $t > s$ . he estimator of this VAR

<sup>2</sup> Only the Economic Growth variable is not in terms of natural logarithm.



Overidentifying Test (p-value)	0.223	0.067	0.12
Number of instruments	72	72	72
Stability Condition	Yes	Yes	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results in Table 1 show that the first definition with which undervaluation is achieved has a negative impact on Economic Growth. The other two undervaluation variables have a positive impact. Figure 01 shows the response of Economic Growth to a shock of each undervaluation:

FIGURE 01:

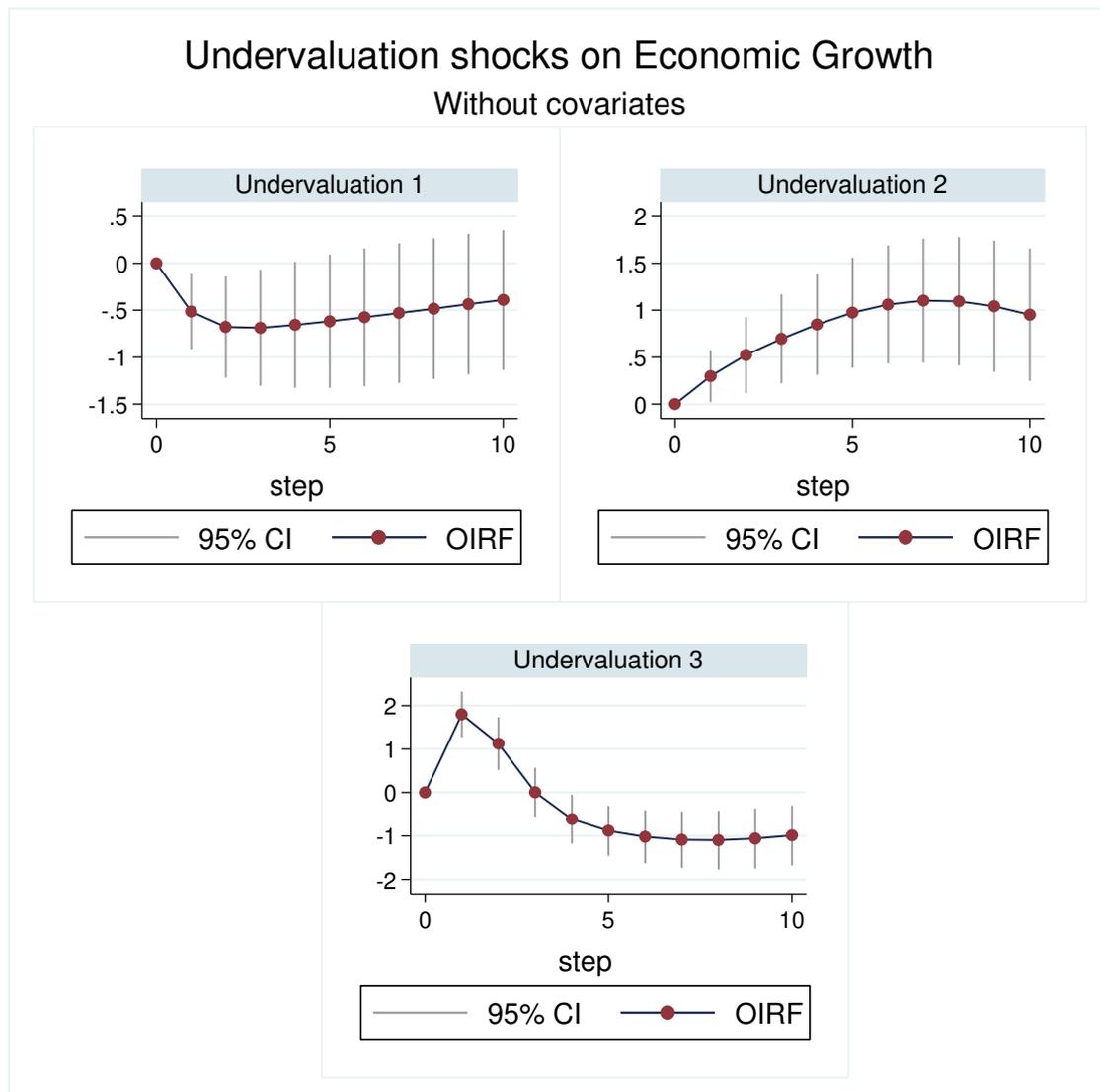


Figure 01 shows that an undervaluation shock 1 causes a negative response from Economic Growth. An undervaluation 2 shock causes a persistent positive response in Economic Growth and, finally, an undervaluation 3 shock causes an increase in Economic Growth in the first period and then begins to decline. Table 03 shows the results when we use the second measure of GDP per capita:

Table 03: Second Stage: Estimating the impact without covariates

Variables	Second GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	-1.12	-3.14***	-3.95***

	(-1.15)	(-4.96)	(-2.74)
Economic Growth $_{i,t-2}$	0.02 (0.64)	-0.11*** (-4.35)	-0.090 (-1.55)
GDP per capita $_{i,t-1}$	0.02 (1.73)	0.04*** (5.74)	0.05** (3.18)
GDP per capita $_{i,t-2}$	-0.02 (-1.74)	-0.04*** (-5.72)	-0.05** (-3.18)
<i>Undervaluation</i> $_{i,t-1}$	-0.01 (-1.54)	-0.02** (-3.00)	0.21*** (7.66)
<i>Undervaluation</i> $_{i,t-2}$	-0.01*** (-5.06)	0.04*** (6.20)	-0.23*** (-8.13)
Observations	385	385	385
Overidentifying Test (p-value)	0.183	0.022	0.897
Number of instruments	72	72	72
Stability Condition	Yes	Not	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results show that the first two undervaluation variables have a negative impact on Economic Growth, while the last one has a positive impact. Figure 02 shows the impulse response graphs:

FIGURE 02:

## Undervaluation shocks on Economic Growth Without covariates

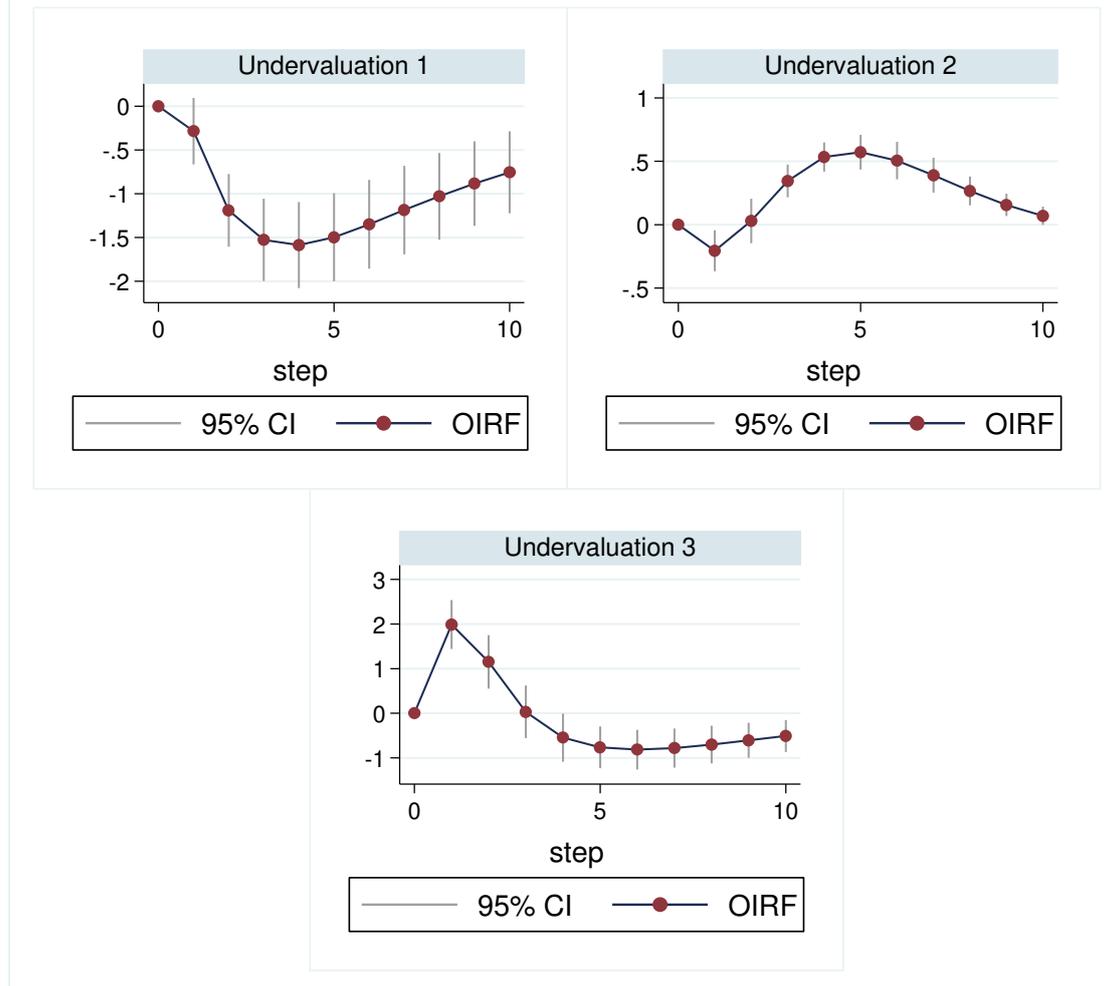


Figure 02 shows that a shock of undervaluation 1 causes a negative response of Economic Growth without bequeathing to recover, undervaluation 2 causes a fall of a period of Economic Growth and then begins to increase. Finally, an undervaluation shock 3 causes an increase in the Economic Growth for two periods and then begins to fall. Table 04 shows the results when we use the third measure of GDP per capita:

Table 04: Second Stage: Estimating the impact without covariates

Variables	Second GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	0.123** (3.23)	0.35*** (9.73)	0.43*** (9.17)
Economic Growth <sub>i,t-2</sub>	-0.04 (-1.18)	-0.09** (-3.18)	-0.13*** (-3.98)
GDP per capita <sub>i,t-1</sub>	0.10*** (11.40)	0.14*** (11.99)	0.05*** (4.43)
GDP per capita <sub>i,t-2</sub>	-0.09*** (-11.15)	-0.13*** (-11.80)	-0.05*** (-4.40)
Undervaluation <sub>i,t-1</sub>	0.04*** (18.41)	0.10*** (10.19)	0.05** (3.15)

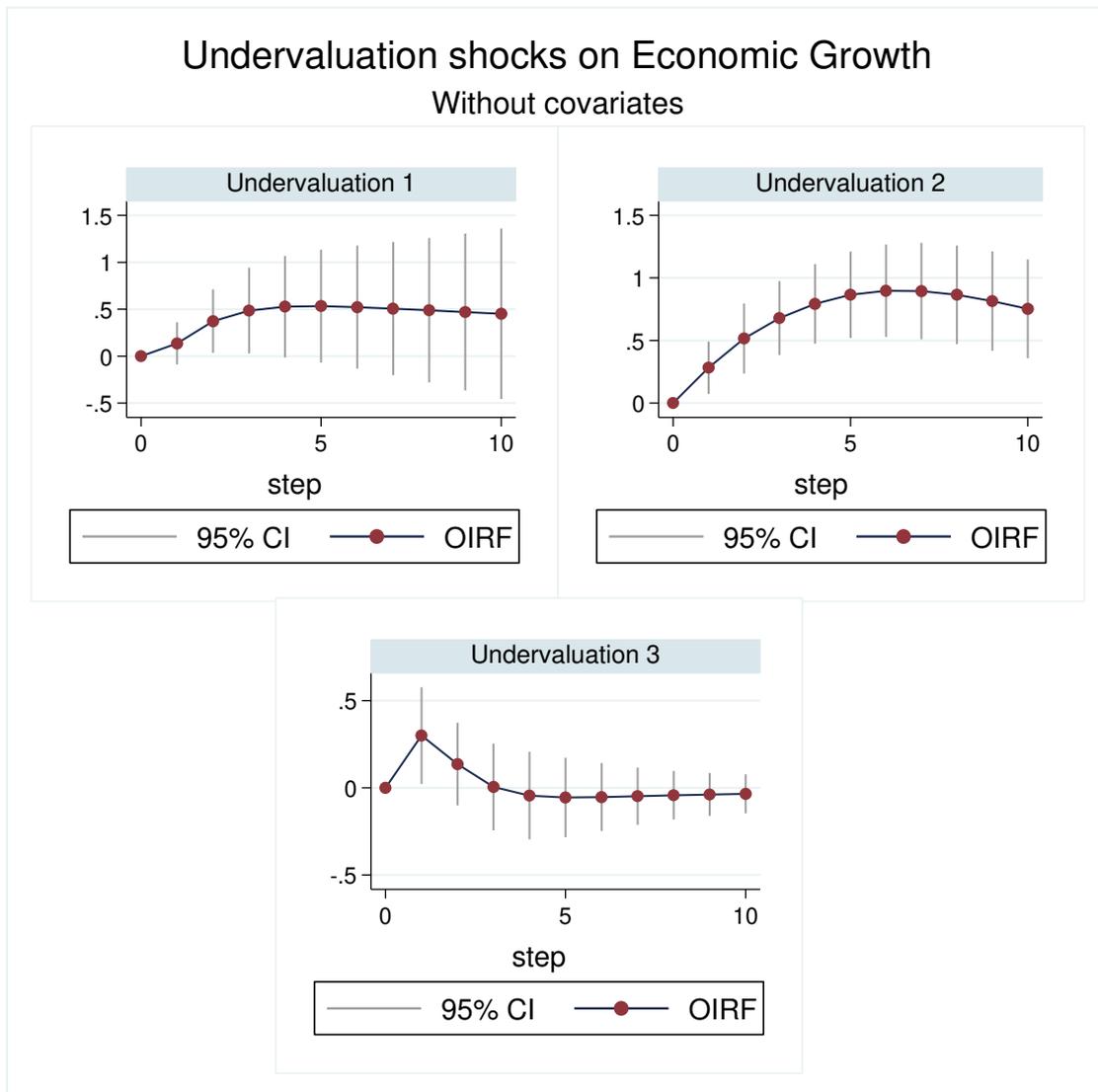
$Undervaluation_{i,t-2}$	-0.04*	-0.10***	-0.08***
	(-2.38)	(-10.14)	(-5.08)
Observations	385	385	385
Overidentifying Test (p-value)	0.276	0.006	0.185
Number of instruments	72	72	72
Stability Condition	Yes	Yes	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results in Table 02 show the coefficients of all undervaluation measures are positive in the first lag and all negative coefficients of the second lag period are negative. Figure 03 shows the impulse-response graphs using this measure of GDP per capita:

FIGURE 03



All the impulse response graphs show a positive response of the Economic Growth from a shock of the Undervaluation measures, the first two are persistent while the third measure returns to zero in the third period. By way of conclusion of this subsection, we find that using the third measure of GDP per capita, all Undervaluation shocks are positive. The first two measures of GDP per capita show divided effects on Economic Growth. Looking at it from the other point of view, the third measure of undervaluation shows a positive impact in the first

periods and then falls. The other two undervaluation measures show different effects. Having presented the results, we move on to the next subsection where we add macroeconomic variables such as government spend, terms of trade and monetary aggregates.

### 3.2 Results with macroeconomics covariates:

Table 05 shows the results by adding macroeconomic variables in our model, using the same GDP per capita measure as Table 02:

Table 05: Second Stage: Estimating the impact with macroeconomics covariates

Variables	First GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	0.50*** (3.35)	0.15** (3.13)	0.28*** (4.84)
Economic Growth <sub>i,t-2</sub>	-0.10 (-0.97)	-0.05 (-1.21)	-0.08* (-2.04)
GDP per capita <sub>i,t-1</sub>	-0.16 (-1.28)	0.24*** (9.11)	0.14*** (4.98)
GDP per capita <sub>i,t-2</sub>	0.18 (1.40)	-0.19*** (-7.18)	-0.10*** (-3.66)
Undervaluation <sub>i,t-1</sub>	0.01 (1.07)	0.03** (3.04)	0.09*** (4.35)
Undervaluation <sub>i,t-2</sub>	0.01 (0.79)	-0.02* (-2.22)	-0.06** (-3.23)
Government Spend <sub>i,t</sub>	-0.03 (-1.27)	-0.07*** (-8.87)	-0.06*** (-6.36)
Terms of trade <sub>i,t</sub>	0.02 (0.51)	0.06*** (9.08)	0.06*** (7.81)
Monetary Aggregates <sub>i,t</sub>	0.00 (0.09)	-0.04*** (-4.23)	-0.02** (-2.62)
Observations	385	385	385
Overidentifying Test (p-value)	0.649	0.083	0.696
Number of instruments	75	75	75
Stability Condition	Yes	Yes	Not

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results in Table 05 show that the first Undervaluation measure has a positive, but not significant impact on the first lag. The other two variables show significance in the coefficients for both their first and second lags. Figure 04 shows the impulse-response graphs of these estimates:

FIGURE 04

## Undervaluation shocks on Economic Growth With Macroeconomic Covariates

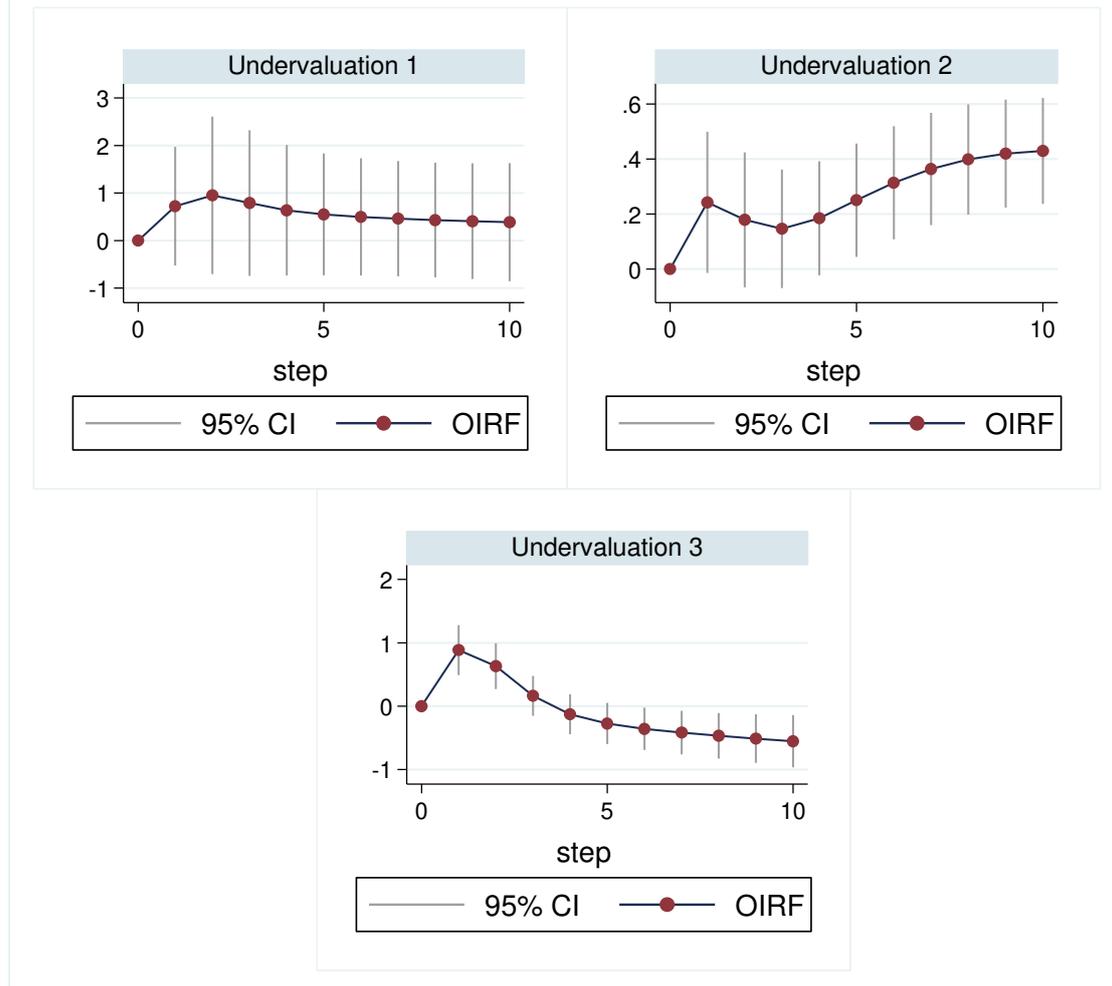


Figure 04 shows positive responses of Economic Growth to an undervaluation shock in all its measures. The first and third measures cause an increase in the first periods, but then decline while the second measure shows a persistent increase over time. Table 06 shows the results when considering the second measure of GDP per capita:

Table 06: Second Stage: Estimating the impact with macroeconomics covariates

Variables	Second GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	-5.19*** (-3.78)	-4.48*** (-5.14)	-5.41*** (-4.38)
Economic Growth <sub>i,t-2</sub>	-0.04 (-0.94)	-0.08* (-2.38)	-0.05 (-1.08)
GDP per capita <sub>i,t-1</sub>	5.49*** (3.96)	4.83*** (5.55)	5.83*** (4.69)
GDP per capita <sub>i,t-2</sub>	-5.45*** (-3.94)	-4.77*** (-5.49)	-5.78*** (-4.65)
Undervaluation <sub>i,t-1</sub>	-0.02 (-0.46)	0.00 (0.12)	0.13*** (6.47)

<i>Undervaluation</i> <sub><i>i,t-2</i></sub>	-0.00 (-0.70)	0.01 (0.84)	-0.09*** (-5.20)
<i>Government Spend</i> <sub><i>i,t</i></sub>	-0.08*** (-7.10)	-0.08*** (-14.10)	-0.08*** (-8.01)
<i>Terms of trade</i> <sub><i>i,t</i></sub>	0.04*** (5.28)	0.06*** (9.17)	0.05*** (6.71)
<i>Monetary Aggregates</i> <sub><i>i,t</i></sub>	0.00 (0.58)	-0.02** (-3.04)	-0.00 (-1.06)
Observations	385	385	385
Overidentifying Test (p-value)	0.724	0.229	0.811
Number of instruments	75	75	75
Stability Condition	Not	Not	Not

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results are varied, the second and third undervaluation measures find positive effects on Economic Growth, the last one having significance, while the first measure finds negative and not significant effects. Figure 05 shows the impulse response graphs of these undervaluation measures on Economic Growth.

FIGURE 05:

## Undervaluation shocks on Economic Growth With Macroeconomic Covariates

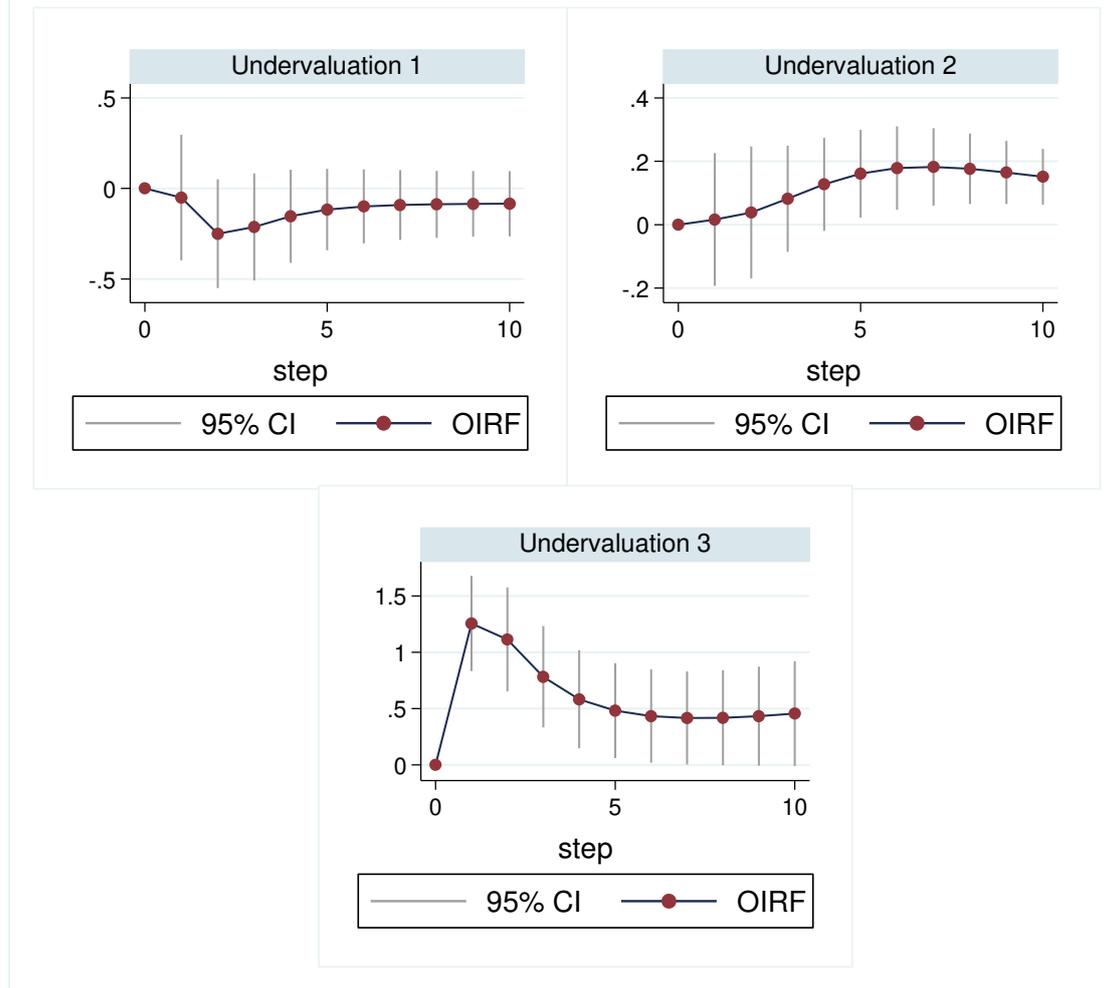


Figure 05 shows scattered results, a shock from the first undervaluation measure causes a drop in Economic Growth and then recovers without compensating for this effect. A shock from the second undervaluation measure causes persistent positive effects on Economic Growth while the last undervaluation measure causes an increase in the first period and then begins to decline, but without compensating for the impact. Table 07 shows the results considering the third measure of GDP per capita.

Table 7: Second Stage: Estimating the impact with macroeconomics covariates

Variables	Third GDP per capita Measure		
Economic Growth <sub>i,t-1</sub>	0.26*** (7.51)	0.54*** (11.54)	0.46*** (6.86)
Economic Growth <sub>i,t-2</sub>	0.03 (1.43)	-0.15*** (-3.53)	-0.14** (-2.92)
GDP per capita <sub>i,t-1</sub>	0.02* (2.23)	-0.12*** (-8.07)	-0.03* (-2.03)
GDP per capita <sub>i,t-2</sub>	-0.01 (-1.62)	0.15*** (9.80)	0.05*** (3.34)
Undervaluation <sub>i,t-1</sub>	0.03***	-0.09***	0.10***

	(17.08)	(-6.40)	(4.08)
<i>Undervaluation</i> <sub><i>i,t-2</i></sub>	0.01*** (4.47)	0.11*** (8.52)	-0.11*** (-4.93)
<i>Government Spend</i> <sub><i>i,t</i></sub>	-0.09*** (-20.06)	-0.13*** (-15.25)	-0.09*** (-6.21)
<i>Terms of trade</i> <sub><i>i,t</i></sub>	0.01*** (3.76)	0.07*** (10.31)	0.07*** (7.89)
<i>Monetary Aggregates</i> <sub><i>i,t</i></sub>	0.03*** (8.10)	-0.02** (-3.21)	-0.01 (-1.53)
Observations	385	385	385
Overidentifying Test (p-value)	0.294	0.227	0.305
Number of instruments	75	75	75
Stability Condition	Not	Yes	Not

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results show that the first and third measure of undervaluation have a positive impact on Economic Growth, while the second measure has negative effects. Figure 06 shows the impulse-response graphs of all undervaluation measures:

FIGURE 06

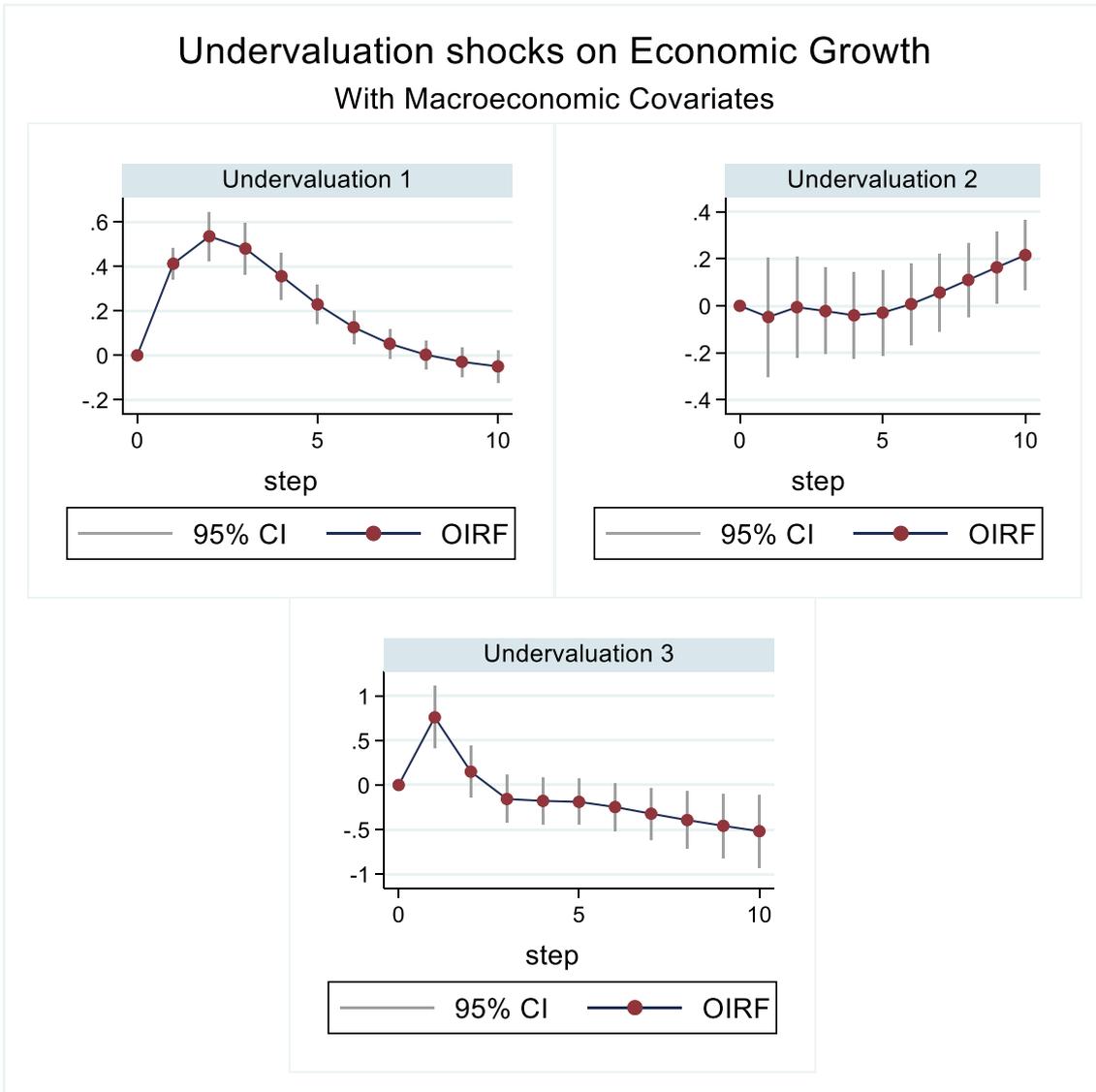


Figure 06 shows the impulse-response graphs, a shock of the first and second measures elicit a positive response from Economic Growth, while the second measure has no impact until the fifth period where it begins to increase. Once the results for this subsection have been presented, by way of conclusion, the third undervaluation measure finds positive impacts on Economic Growth, while the other measures show scattered results. Now, we move on to the third subsection, in which we include human capital variables such as average worked hours, human capital index and productivity.

### 3.3 Results with human capital covariates:

Table 08 shows the results with the first GDP per capita measure:

Table 08: Second Stage: Estimating the impact with human capital covariates

Variables	First GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	0.12* (2.21)	0.25*** (5.25)	0.05 (0.75)
Economic Growth <sub>i,t-2</sub>	-0.14*** (-4.03)	-0.04 (-0.97)	-0.03 (-0.64)
GDP per capita <sub>i,t-1</sub>	0.24***	0.12**	0.04

	(5.73)	(3.17)	(0.85)
GDP per capita $_{i,t-2}$	-0.27*** (-7.76)	-0.25*** (-8.09)	-0.21*** (-5.26)
<i>Undervaluation</i> $_{i,t-1}$	0.00 (1.41)	0.10*** (8.91)	0.10*** (4.99)
<i>Undervaluation</i> $_{i,t-2}$	-0.00 (-0.44)	-0.10*** (-8.11)	0.02 (0.99)
<i>Average Hours Worked</i> $_{i,t}$	0.02*** (4.48)	0.01*** (3.29)	0.01** (2.81)
<i>Human Capital index</i> $_{i,t}$	0.09 (1.67)	0.44*** (7.61)	0.62** (9.24)
<i>Productivity</i> $_{i,t}$	0.04 (1.51)	0.17*** (6.62)	0.18*** (6.07)
Observations	385	385	385
Overidentifying Test (p-value)	0.307	0.155	0.414
Number of instruments	75	75	75
Stability Condition	Yes	Yes	Yes

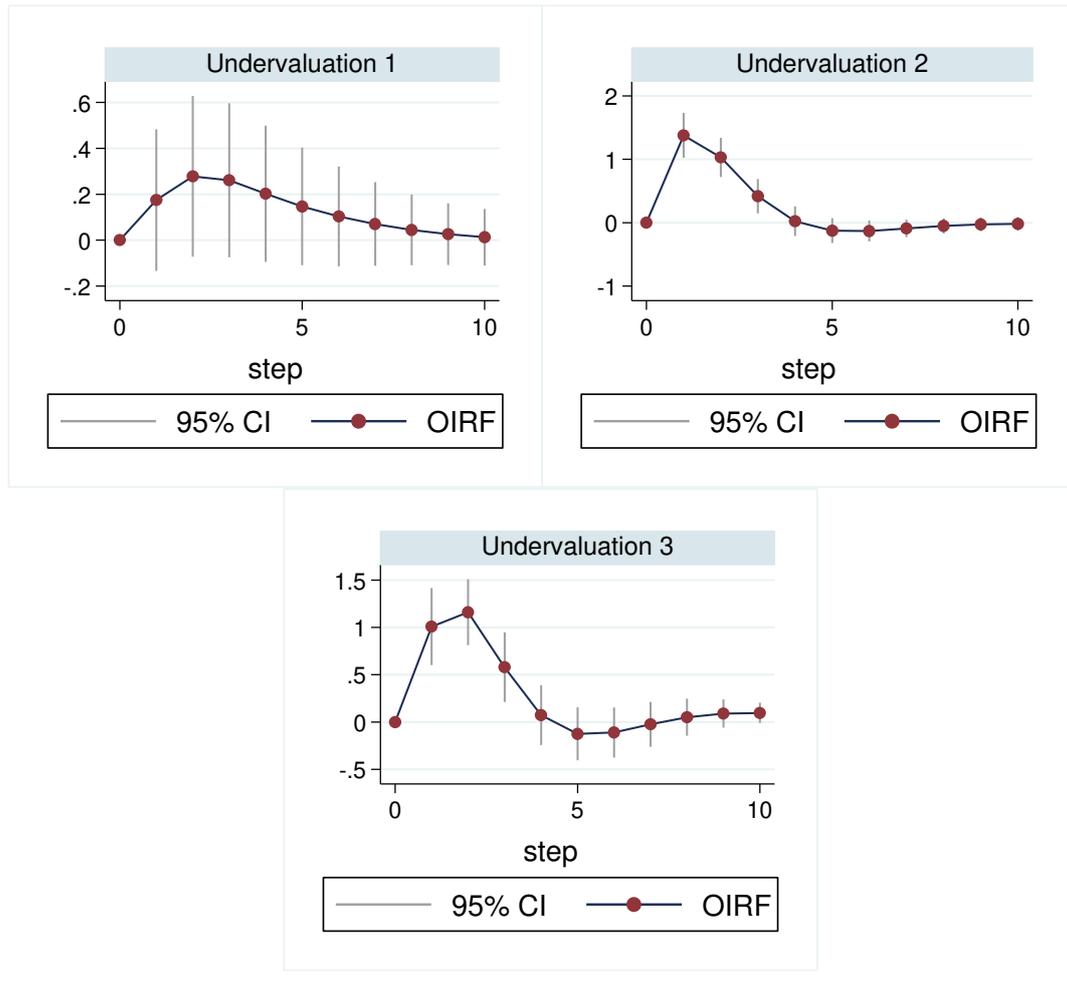
t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results in Table 08 show that all the undervaluation measures have positive impacts on Economic Growth. Figure 07 shows the impulse-impulse response graphs of all undervaluation measures on Economic Growth.

FIGURE 07

## Undervaluation shocks on Economic Growth With Human Capital Covariates



Impulse-response graphs show a positive impact of undervaluation measures on Economic Growth up to the third period and then start to decline. The second and third measures compensate reach zero in the fourth and fifth period respectively, while the first measure compensates in the tenth period. Table 09 shows the results when we use the second measure of GDP per capita.

Table 09: Second Stage: Estimating the impact with human capital variables

Variables	Second GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	3.88*** (3.37)	5.05*** (3.70)	2.29 (1.31)
Economic Growth <sub>i,t-2</sub>	-0.06 (-1.70)	-0.12** (-3.06)	-0.08 (-1.74)
GDP per capita <sub>i,t-1</sub>	-3.42** (-2.97)	-4.80*** (-3.47)	-2.02 (-1.14)
GDP per capita <sub>i,t-2</sub>	3.41** (2.96)	4.65*** (3.36)	1.89 (1.07)
Undervaluation <sub>i,t-1</sub>	0.02** (2.87)	0.03*** (4.33)	0.09*** (4.55)

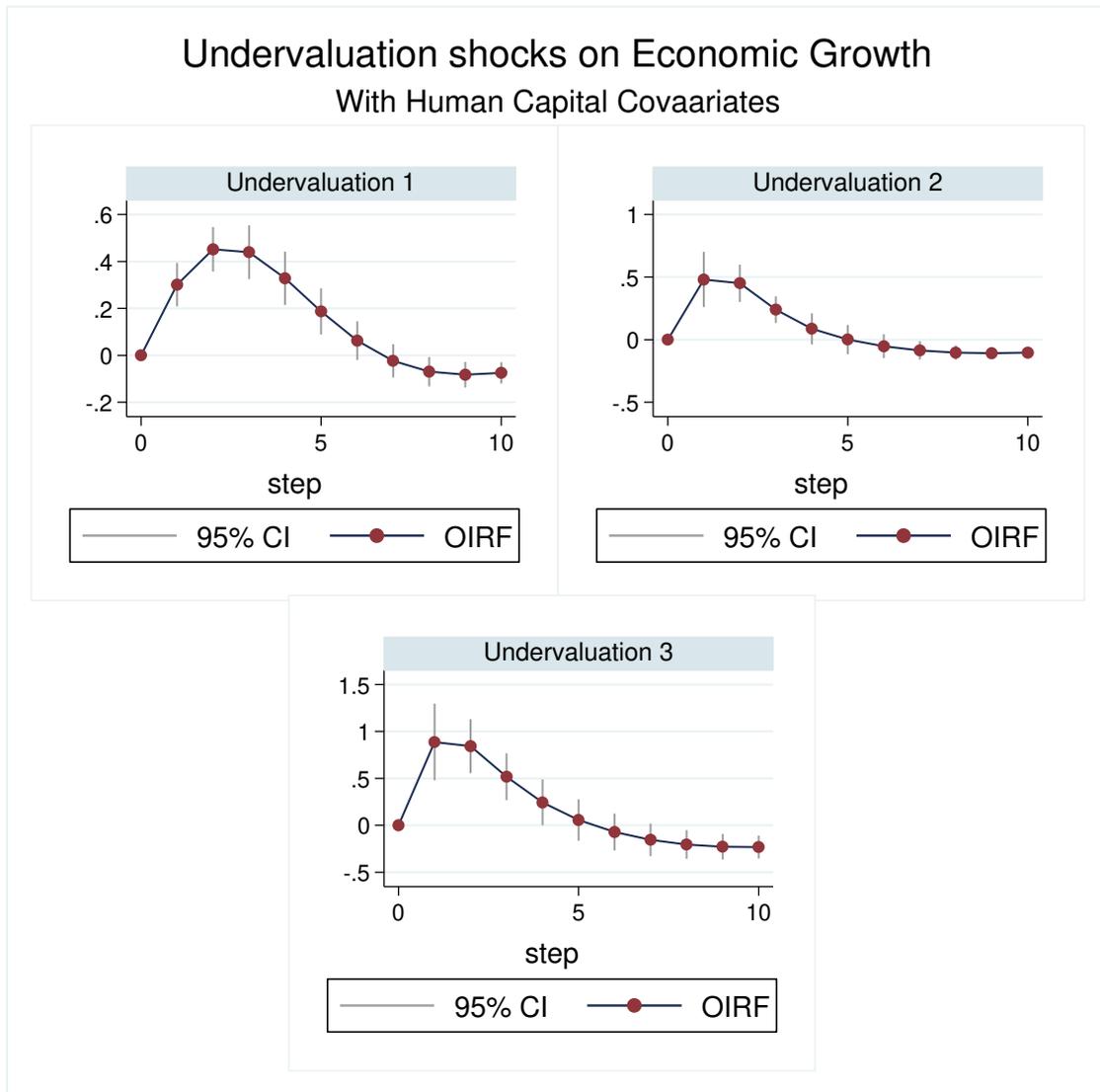
<i>Undervaluation</i> <sub><i>i,t-2</i></sub>	-0.02** (-3.00)	-0.02** (-2.70)	-0.03 (-1.59)
<i>Average Hours Worked</i> <sub><i>i,t</i></sub>	0.01** (3.25)	0.01** (2.70)	-0.00 (-0.63)
<i>Human Capital index</i> <sub><i>i,t</i></sub>	0.01 (0.47)	0.35*** (13.19)	0.31*** (8.76)
<i>Productivity</i> <sub><i>i,t</i></sub>	-0.01 (-1.24)	0.08*** (6.01)	0.04** (2.98)
Observations	385	385	385
Overidentifying Test (p-value)	0.354	0.120	0.747
Number of instruments	75	75	75
Stability Condition	Yes	Yes	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results show positive impacts of undervaluation measures on Economic Growth. Figure 08 shows the impulse response graphs.

FIGURE 08



The results in figure 08 show that the three undervaluation measures provoke a positive response in the Economic Growth until the third period and then begin to decrease below zero. Table 10 shows the results using the third measure of GDP per capita.

Table 10: Second Stage: Estimating the impact with human capital variables

Variables	Third GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth $_{i,t-1}$	0.36*** (7.27)	0.28*** (9.62)	0.30*** (6.16)
Economic Growth $_{i,t-2}$	0.00 (0.10)	-0.13*** (-6.42)	-0.05 (-1.51)
GDP per capita $_{i,t-1}$	0.04*** (4.16)	-0.13*** (-13.44)	0.00 (0.99)
GDP per capita $_{i,t-2}$	-0.05*** (-5.16)	0.13*** (13.83)	-0.03*** (-3.33)
Undervaluation $_{i,t-1}$	0.02*** (9.52)	-0.20*** (-21.12)	0.09*** (5.18)
Undervaluation $_{i,t-2}$	-0.00 (-1.20)	0.26*** (25.29)	-0.06*** (-3.65)
Average Hours Worked $_{i,t}$	-0.01 (-0.17)	0.26*** (6.11)	-0.01 (-0.10)
Human Capital index $_{i,t}$	0.05** (3.13)	0.14*** (9.80)	0.12*** (6.54)
Productivity $_{i,t}$	0.01 (1.68)	-0.00 (-0.26)	-0.02 (-1.84)
Observations	385	385	385
Overidentifying Test (p-value)	0.328	0.330	0.263
Number of instruments	75	75	75
Stability Condition	Yes	Yes	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results in Table 10 show that the first and third measures have positive impacts on Economic Growth, while the second measure has a negative impact. Figure 09 shows the impulse-response graphs.

FIGURE 09

## Undervaluation shocks on Economic Growth With Human Capital Covariates

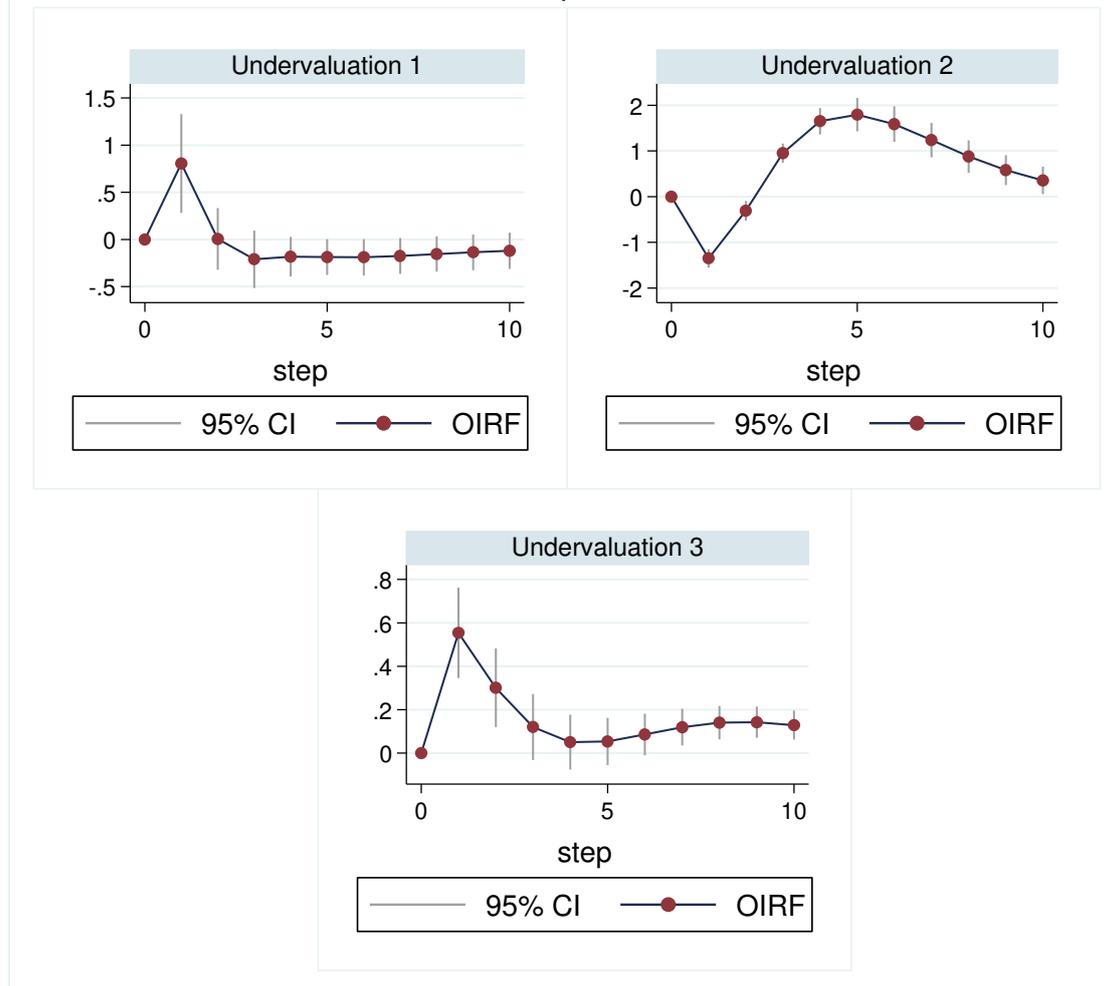


Figure 09 shows that a shock of the first and second undervaluation measures has a positive response from Economic Growth, however, the first measure falls below zero while the third remains positive for the rest of the periods. The second measure has a negative impact below zero, but increasing until it is above zero for the rest of the periods. So, once this subsection is finished, by way of conclusion we find that the first and third measures have a positive impact on Economic Growth subject to all GDP per capita measures. While the second measure of undervaluation shows a positive impact on the first measure and second measure of GDP per capita, with the third measure we find that there is a negative impact in the first period, but then it has an increase staying above zero. The following subsection shows the results including all variables, that is, including government spend, terms of trade, monetary aggregates, average worked hours, human capital index and productivity.

### 3.4 Results with all covariates:

Table 11 shows the results considering all the variables and using the first measure of GDP per capita:

Table 11: Second Stage: Estimating the impact with all covariates

Variables	First Economic Growth Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	0.09 (1.35)	0.32*** (4.59)	0.17 (1.58)

Economic Growth $_{i,t-2}$	-0.21*** (-5.04)	-0.07 (-1.28)	-0.05 (-0.77)
GDP per capita $_{i,t-1}$	0.27*** (6.09)	0.10* (2.05)	0.04 (0.61)
GDP per capita $_{i,t-2}$	-0.17*** (-5.01)	-0.16*** (-3.85)	-0.13* (-2.10)
Undervaluation $_{i,t-1}$	0.01** (3.25)	0.15*** (7.58)	0.14*** (4.75)
Undervaluation $_{i,t-2}$	-0.00 (-0.20)	-0.14*** (-6.59)	-0.01 (-0.36)
Average Hours Worked $_{i,t}$	0.00 (0.28)	0.01** (2.96)	0.01 (1.73)
Human Capital index $_{i,t}$	-0.13* (-2.54)	0.23*** (4.55)	0.32*** (4.65)
Productivity $_{i,t}$	-0.05 (-1.92)	0.086** (3.17)	0.06 (1.56)
Government Spend $_{i,t}$	-0.09*** (-6.86)	-0.02 (-1.76)	-0.01 (-0.58)
Terms of Trade $_{i,t}$	0.05*** (5.12)	0.01 (0.89)	-0.00 (-0.18)
Monetary Aggregates $_{i,t}$	-0.04*** (-4.40)	0.00 (0.23)	0.01 (0.89)
Observations	385	385	385
Overidentifying Test (p-value)	0.476	0.151	0.870
Number of instruments	78	78	54
Stability Condition	Yes	Yes	Yes

t statistics in parentheses

\*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$

The results in Table 11 show that undervaluation has a positive impact on Economic Growth when the first measure of GDP per capita is used. Figure 10 shows the impulse-response graphs of the undervaluation measures on Economic Growth. Figure 10 shows the impulse-response graphs.

FIGURA 10

## Undervaluation shocks on Economic Growth With All Covariates

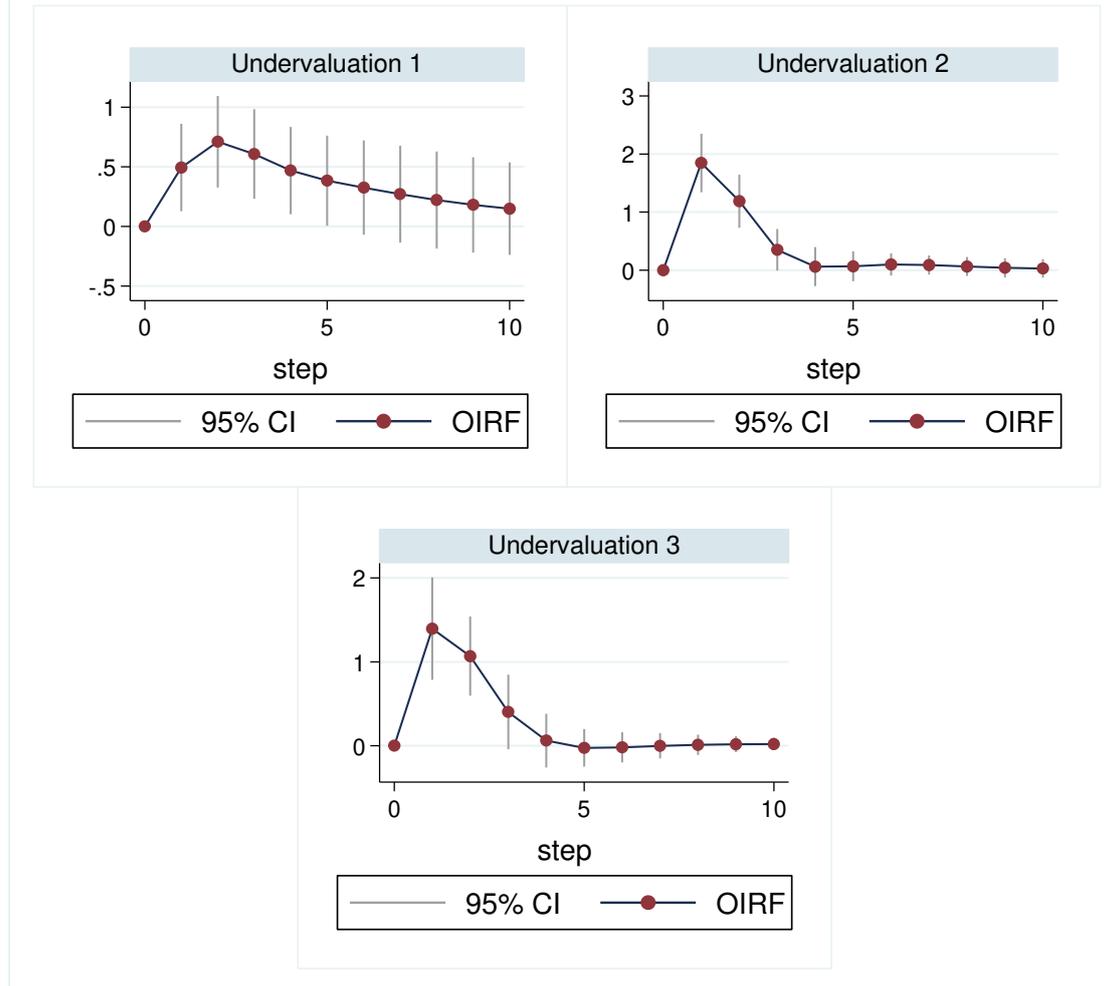


Figure 10 shows that a positive shock from Undervaluation positively impacts Economic Growth, but the second and third measures are compensated until the fourth period for both, while the first measure is not compensated in the first 10 periods. Table 12 shows the results using the second measure of GDP per capita.

Table 12: Second Stage: Estimating the impact with all covariates

Variables	First GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	-7.85*** (-4.86)	-6.84*** (-6.36)	-5.42*** (-3.88)
Economic Growth <sub>i,t-2</sub>	-0.11** (-2.61)	-0.09* (-1.97)	-0.06 (-1.42)
GDP per capita <sub>i,t-1</sub>	8.12*** (5.01)	7.00*** (6.56)	5.69*** (4.06)
GDP per capita <sub>i,t-2</sub>	-8.08*** (-4.97)	-7.07*** (-6.60)	-5.70*** (-4.06)
Undervaluation <sub>i,t-1</sub>	0.01 (1.54)	0.05*** (6.28)	0.11*** (5.94)
Undervaluation <sub>i,t-2</sub>	-0.00	-0.03***	-0.04*

	(-0.53)	(-4.38)	(-2.40)
<i>Average Hours Worked</i> <sub><i>i,t</i></sub>	0.01 (1.24)	0.01*** (4.00)	0.00 (0.07)
<i>Human Capital index</i> <sub><i>i,t</i></sub>	-0.04 (-1.16)	0.21*** (6.58)	0.16*** (6.20)
<i>Productivity</i> <sub><i>i,t</i></sub>	0.06** (3.24)	0.16*** (9.51)	0.06*** (3.67)
<i>Government Spend</i> <sub><i>i,t</i></sub>	-0.05*** (-4.16)	-0.01 (-1.75)	-0.05*** (-4.58)
<i>Terms of Trade</i> <sub><i>i,t</i></sub>	0.05*** (6.57)	0.08*** (10.27)	0.06*** (6.07)
<i>Monetary Aggregates</i> <sub><i>i,t</i></sub>	-0.01 (-0.86)	-0.02* (-2.43)	-0.03*** (-3.85)
Observations	385	385	385
Overidentifying Test (p-value)	0.840	0.177	0.702
Number of instruments	77	77	77
Stability Condition	Not	Yes	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

The results in Table 12 show the estimates using the second measure of GDP per capita, we found positive results in all the estimates, but significant only in the second and third measure of undervaluation. Figure 11: Shows the impulse response graphs.

FIGURA 11

## Undervaluation shocks on Economic Growth With All Covariates

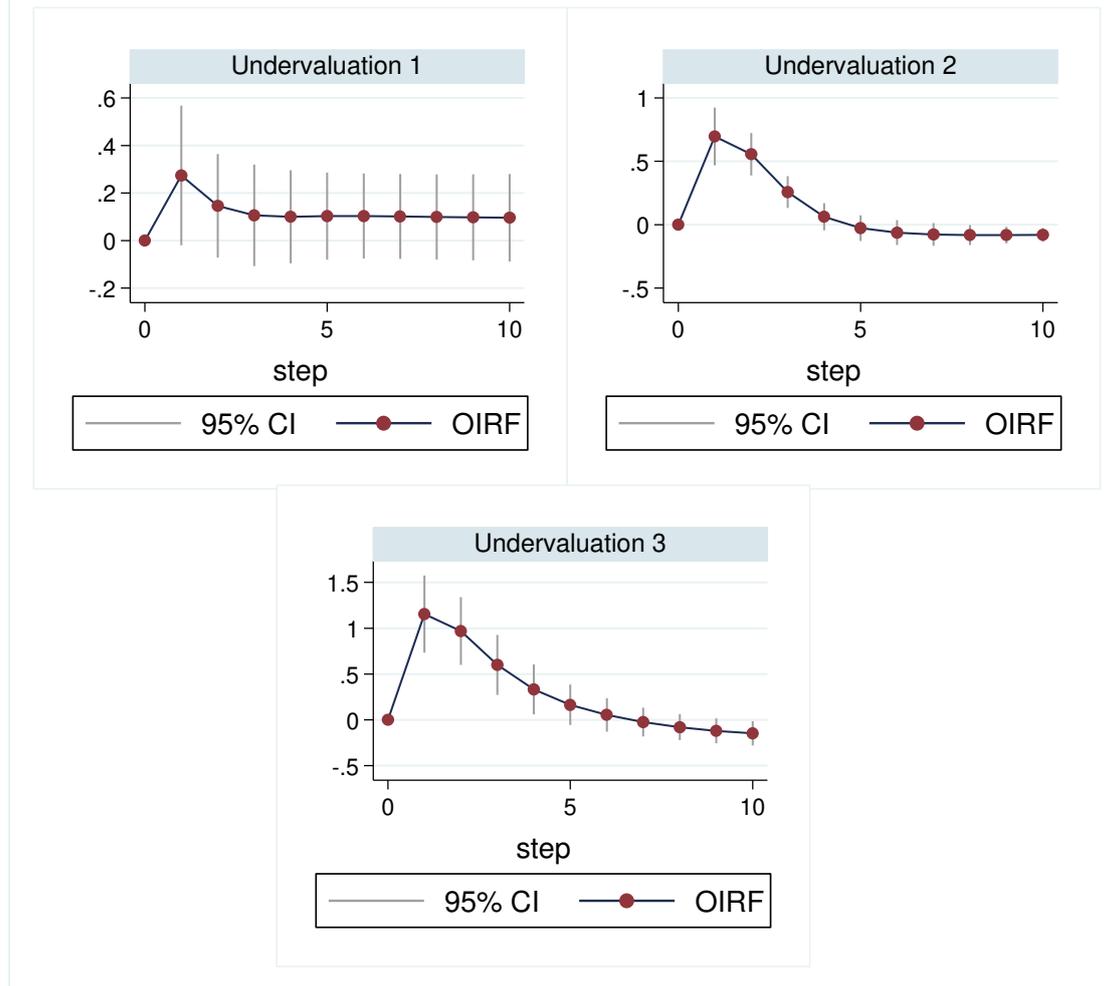


Figure 11 shows that a shock of all undervaluation measures causes an increase in Economic Growth, only the second and third measures are offset by reaching zero, while the first measure remains constant in all periods. And finally, Table 13 shows the estimates considering the third measure of GDP per capita.

Table 13: Second Stage: Estimating the impact with all covariates

Variables	First GDP per capita Measure		
	(1)	(2)	(3)
Economic Growth <sub>i,t-1</sub>	0.30*** (5.70)	0.22*** (6.52)	0.13** (2.62)
Economic Growth <sub>i,t-2</sub>	0.03 (0.83)	-0.16*** (-6.45)	-0.06 (-1.48)
GDP per capita <sub>i,t-1</sub>	-0.06*** (-6.45)	-0.17*** (-15.31)	-0.02 (-1.56)
GDP per capita <sub>i,t-2</sub>	0.05*** (6.17)	0.19*** (15.76)	0.01 (0.88)
Undervaluation <sub>i,t-1</sub>	-0.02** (-3.28)	-0.21*** (-17.39)	0.09*** (6.48)
Undervaluation <sub>i,t-2</sub>	0.02**	0.26***	-0.04***

	(2.93)	(24.52)	(-3.97)
<i>Average Hours Worked</i> <sub><i>i,t</i></sub>	-0.03 (-0.57)	0.18*** (4.48)	0.06 (0.78)
<i>Human Capital index</i> <sub><i>i,t</i></sub>	-0.03 (-1.47)	0.01 (0.66)	-0.07*** (-3.32)
<i>Productivity</i> <sub><i>i,t</i></sub>	0.10*** (8.10)	0.11*** (11.43)	0.13*** (11.36)
<i>Government Spend</i> <sub><i>i,t</i></sub>	-0.11*** (-10.97)	-0.05*** (-7.71)	-0.01 (-0.94)
<i>Terms of Trade</i> <sub><i>i,t</i></sub>	0.08*** (11.14)	0.12*** (18.57)	0.15*** (17.41)
<i>Monetary Aggregates</i> <sub><i>i,t</i></sub>	0.02*** (6.24)	0.00 (0.69)	0.02*** (4.69)
Observations	385	385	385
Overidentifying Test (p-value)	0.253	0.408	0.636
Number of instruments	77	77	77
Stability Condition	Yes	Yes	Yes

t statistics in parentheses

\* p<0.05, \*\* p<0.01, \*\*\* p<0.001

Figure 11 shows that a shock of all undervaluation measures causes an increase in Economic Growth, only the second and third measures are offset by reaching zero, while the first measure remains constant in all periods. And finally, Table 13 shows the estimates considering the third measure of GDP per capita.

FIGURA 12

## Undervaluation shocks on Economic Growth With All Covariates

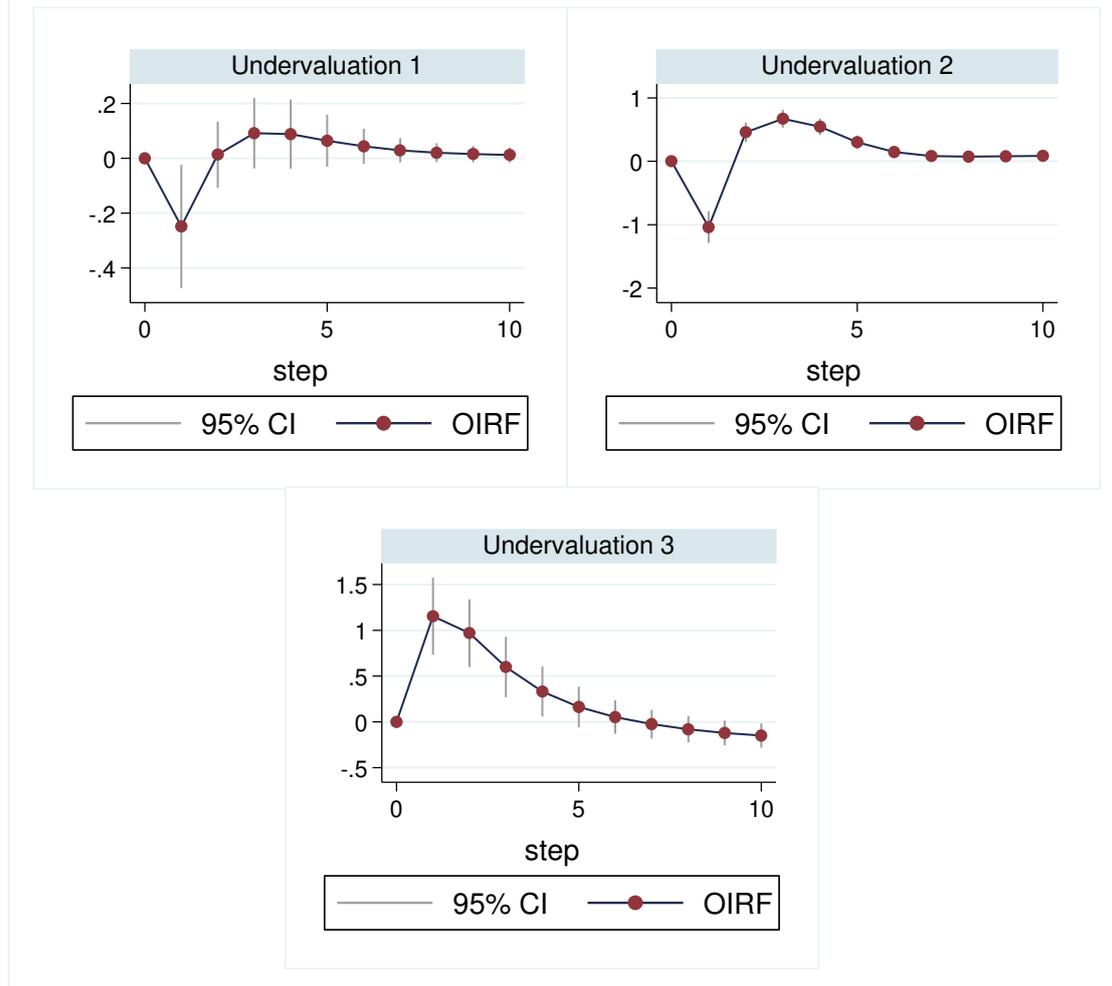


Figure 12 shows that the first and second undervaluation measures have negative impacts on the Economic Growth while the third measure has positive impacts increasing in the first period and then falling to below 0. So, the results of this section that only the third measure of undervaluation shows positive effects on all measures of GDP per capita, while the other measures show scattered results. In the next section, we present the conclusions of this study, and in the annex we present the Granger causality tests of all the estimates made in this investigation.

#### 4. Conclusion

The results of this research show that there are positive effects of an undervaluation on Economic Growth, considering the third measure of Undervaluation for all definitions of GDP per capita, which is also used to construct the Economic Growth per capita. These significant effects find a change of 1% of undervaluation can positively impact between 5% and 19% of economic growth. While the other two undervaluation measures show dispersed effects depending on the measures of GDP per capita and the variables included.

If we look at the first measure of undervaluation, without considering macroeconomic and human capital variables, that is, considering the results of tables 02-04, we find that there is a positive effect only in one of the three measures of GDP per capita and we only find significance in the first measure of GDP per capita. Considering including macroeconomic variables, that is, considering the results of tables 05-07, we found positive effects in the first and third measure of GDP per capita, but only significance in the last measure. Considering the human capital variables, that is, considering the results of tables 08-10, we found positive effects on all measures

of GDP per capita, but only significance in the second and third measures. Lastly, considering all the macroeconomic and human capital variables, that is, considering the results in Tables 11-13, we found positive effects in the first and second measure of GDP per capita, but only significance in the first measure.

Turning to the second measure of undervaluation, without considering including variables, that is, the results of Table 02-04, we found positive and significant effects in the first and third measures of GDP per capita. Considering the macroeconomic variables, that is, the results in Table 05-07, we found positive effects in the first and second measure of GDP per capita, but only significance in the first. Considering the human capital variables, that is, the results in Table 08-10, we found positive effects and significance in the first and second measures of GDP per capita. Finally, considering all the variables, that is, considering Tables 11-13, we found positive effects and significance in the first and second measure of GDP per capita.

#### References

- Aguirre, A., Calderòn, C., 2005. Real Exchange Rate Misalignments and Economic Performance. *Journal of International Money and Finance*, 24(2), 171–188.
- Arellano, M., and S. Bond. 1991. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. *Review of Economic Studies*, 58(2), 201–215.
- Blundell, R. & Bond, S. 1998. Initial conditions and moments restrictions in dynamic panel data models. *Journal of Econometrics*. 87: 115-143
- Chou, L. and Chao, C. 2001. Are currency devaluations effective? A panel unit root test, *Economics Letters*, 72, 19–25.
- Christopoulos, D. K. (2004). Currency devaluation and output growth: new evidence from panel data analysis. *Applied Economics Letters*, 11(13), 809–813. doi:10.1080/1350485042000254647
- Clark, P. B., & MacDonald, R. 1999. Exchange Rates and Economic Fundamentals: A Methodological Comparison of Beers and Feers. *Equilibrium Exchange Rates*, 285–322. doi:10.1007/978-94-011-4411-7\_10
- Contractor, Farok J. 2019., What Do We Mean by Undervalued or Overvalued Currencies? *Rutgers Business Review*, 4(1). Available at SSRN: <https://ssrn.com/abstract=3378638>
- Cottani, J.A., Cavallo, D.F., Khan, M.S., 1990. Real exchange rate behavior and economic performance in LDCs. *Economic Development and Cultural Change*, 61–76. Discussion Paper 2011-04.
- Balassa, B., 1982. *Development Strategies in Semi-Industrial Economies*. The World Bank, Washington, DC
- Economics Discussion Paper No. 0809-13, Columbia University.
- Frankel, J. 2006. On the Yuan: The Choice between Adjustment under Fixed Exchange Rate and Adjustment under a Flexible Rate. *CESifo Economic Studies*. 52(2)
- Frankel, J.A., Romer, D., 1999. Does trade cause growth? *American Economic Review*, 379–399.
- Froot, K. A., & Rogoff, K. 1995. Chapter 32 Perspectives on PPP and long-run real exchange rates. *Handbook of International Economics*, 1647–1688. doi:10.1016/s1573-4404(05)80012-7
- Galindo, A., Izquierdo, A. & Montero, A. 2006, Real Exchange Rates, Dollarization, and Growth. *Journal of International Money and Finance*, 25(2), 201–218.
- Ghura, D., Grennes, T.J., 1993. The real exchange rate and macroeconomic performance in Sub-Saharan Africa. *Journal of Development Economics* 42, 155–174
- Glüzmann, P. A., Levy-Yeyati, E., & Sturzenegger, F. (2012). Exchange rate undervaluation and economic growth: Díaz Alejandro (1965) revisited. *Economics Letters*, 117(3), 666–672. doi:10.1016/j.econlet.2012.07.022
- Habib, M. M., Mileva, E., & Stracca, L. 2017. The real exchange rate and economic growth: Revisiting the case using external instruments. *Journal of International Money and Finance*, 73, 386–398. doi:10.1016/j.jimonfin.2017.02.014
- Hausmann, R., Pritchett, L., Rodrik, D., 2005. Growth accelerations. *Journal of Economic Growth* 10 (4), 303–329
- Henry, P.B., 2008. Comments on the real exchange rate and economic growth. *Brookings Papers on Economic Activity*, 413–420

- How Much Has Happened?, John Williamson, ed. Washington, Institute for International Economics.
- Industrial Employment in Latin America, InterAmerican Development Bank. Working Paper 575
- Kappler, M., H. Reisen, M. Schularick, & E. Turkisch, 2012, The Macroeconomic Effects
- Krugman P., 1989. Surévaluation et accélération des productivités : un modèle spéculatif in Laussel D. and C. Montet (eds.), Commerce international et concurrence parfaite, Paris, Economica, 121-135.
- Gylfason, T., & Schmid, M. .1983. Does Devaluation Cause Stagflation? The Canadian Journal of Economics, 16(4), 641. doi:10.2307/135045
- Krugman, P. and Taylor, L. 1978. Contractionary effect of devaluation, Journal of International Economics, 8, 445–56.
- Lanau, S. 2017. The Sectoral Effects of Real Depreciations in Latin America. IMF Working Papers, 17(249), 1. doi:10.5089/9781484328477.001
- MacDonald, R., & Ricci, L. A. 2005. The Real Exchange Rate and the Balassa-Samuelson Effect: The role of the distribution sector. Pacific Economic Review, 10(1), 29–48. doi:10.1111/j.1468-0106.2005.00259.x
- Mejía-Reyes, P., Osborn, D. R., & Sensier, M. (2010). Modelling real exchange rate effects on output performance in Latin America. Applied Economics, 42(19), 2491–2503. doi:10.1080/00036840701858117
- Montiel, P.J., Servén, L., 2009. Real Exchange Rates, Saving, and Growth: Is There a Link? Commission on Growth and Development. Working Paper 46. The World Bank, Washington, DC
- Nouira, R., Sekkat, K., 2012. Desperately seeking the positive impact of undervaluation on growth. Journal of Macroeconomics doi:10.1016/j.jmacro.2011.12.002.
- Bhalla, S. S., 2007. Economic development and the role of currency undervaluation. The Cato Journal, 28(2).
- Eichengreen, B., 2008. The Real Exchange Rate and Economic Growth. Commission on Growth and Development Working Paper 4, The World Bank.
- McLoed, D., Mileva, E., 2011. Real Exchange Rates and Growth Surges. Fordham Economics of Large Exchange Rate Appreciations. Open Economies Review, 24(3).
- Sachs, J. D., Warner, A., Aslund, A., & Fischer, S. .1995.. Economic Reform and the Process of Global Integration. Brookings Papers on Economic Activity, 1995(1), 1. doi:10.2307/2534573
- Studies 58: 277–297.
- Taylor, L. and Rosenweig, J. 1984 Devaluation, capital flows, and crowding out: a CGE model with portfolio choice for Thailand, The World Bank, Working Paper.
- Williamson, J., 1990. What Washington Means by Policy Reform, in Latin American Adjustment: Woodford, M., 2009. Is an Undervalued Currency the Key to Economic Growth? Department of Working Paper 315, Economic Research Division, Central Bank of Chile.
- Rodrik, D., 2008. The Real Exchange Rate and Economic Growth. Brookings Papers on Economic Activity, 2, 365–412.
- Yang, J., Zhang, W., & Tokgoz, S. (2013). Macroeconomic impacts of Chinese currency appreciation on China and the Rest of World: A global CGE analysis. Journal of Policy Modeling, 35(6), 1029–1042. doi:10.1016/j.jpolmod.2013.07.003
- Zicchino, L., & Love, I. 2002. Financial Development and Dynamic Investment Behavior: Evidence from Panel Vector Autoregression. Policy Research Working Papers. doi:10.1596/1813-9450-2913

Annex

Tabla 14: Panel VAR-Granger causality Wald test(without covariates)

---

	First Economic Growth measre	Second Economic Growth Measure	Third Economic Growth measure
First Undervaluation measure	0.011	0.000	0.000
Second Undervaluation measure	0.001	0.000	0.000
Third Undervaluation measure	0.000	0.000	0.000

Ho: Excluded variable does not Granger-cause Equation variable  
Ha: Excluded variable Granger-causes Equation variable

Tabla 15: Panel VAR-Granger causality Wald test(Macroeconomics variables)

	First Economic Growth measre	Second Economic Growth Measure	Third Economic Growth measure
First Undervaluation measure	0.500	0.247	0.000
Second Undervaluation measure	0.000	0.005	0.000
Third Undervaluation measure	0.000	0.000	0.000

Ho: Excluded variable does not Granger-cause Equation variable  
Ha: Excluded variable Granger-causes Equation variable

Tabla 16: Panel VAR-Granger causality Wald test(Human capital covariates)

	First Economic Growth measre	Second Economic Growth Measure	Third Economic Growth measure
First Undervaluation measure	0.275	0.110	0.000
Second Undervaluation measure	0.000	0.000	0.000
Third Undervaluation measure	0.000	0.000	0.000

Ho: Excluded variable does not Granger-cause Equation variable  
Ha: Excluded variable Granger-causes Equation variable

Table 17: List of countries

Bolivia	Brazil	Chile
Colombia	Costa Rica	Dominican Republic
Guatemala	México	Paraguay
Perú	Uruguay	

Table 18: List of Variables

Variable	Definition	Source
First Economic Growth per capita	Expenditure-side real GDP at chained PPPs, to compare relative living standards across countries and over time divided by population	Penn World Table v9.1

Second Economic Growth per capita	<p>GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources divided by population. Data are in constant 2010 U.S. dollars.</p>	World Bank
Third Economic Growth per capita	<p>GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources divided by population. Data are in current U.S. dollars.</p>	World Bank
Nominal Exchange Rate	<p>Official exchange rate refers to the exchange rate determined by national authorities or to the rate determined in the legally sanctioned exchange market. It is calculated as an annual average based on monthly averages (local currency units relative to the U.S. dollar).</p>	World Bank
Producer Price Index (U.S)	<p>Average change over time in the selling prices received by domestic producer for their output</p>	IMF

Consumer Price Index	Consumer price index reflects changes in the cost to the average consumer of acquiring a basket of goods and services that may be fixed or changed at specified intervals, such as yearly. The Laspeyres formula is generally used. Data are period averages.	World Bank
PPP	Purchasing power parity conversion factor is the number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as U.S. dollar would buy in the United States. This conversion factor is for GDP. For most economies PPP figures are extrapolated from the 2011 International Comparison Program (ICP) benchmark estimates or imputed using a statistical model based on the 2011 ICP. For 47 high- and upper middle-income economies conversion factors are provided by Eurostat and the Organisation for Economic Co-operation and Development (OECD).	World Bank
First Real Exchange Rate	The first RER is the Nominal Exchange Rate divided by PPP	Own Estimation
Second Real Exchange Rate	This RER is the multiplication of Nominal Exchange Rate and Producer Price Index divided by Consumer Price Index	Own Estimation
Third Real Exchange Rate	Inverse of Price level of CGDPo, price level of USA GDPo in 2011=1	Penn World Table v9.1

Government Spend	General government final consumption expenditure (formerly general government consumption) includes all government current expenditures for purchases of goods and services (including compensation of employees). It also includes most expenditures on national defense and security, but excludes government military expenditures that are part of government capital formation.	World Bank
Terms of Trade	The terms of trade effect equals capacity to import less exports of goods and services in constant prices. Data are in constant local currency.	World Bank
Monetary Aggregates	Broad money (IFS line 35L..ZK) is the sum of currency outside banks; demand deposits other than those of the central government; the time, savings, and foreign currency deposits of resident sectors other than the central government; bank and traveler's checks; and other securities such as certificates of deposit and commercial paper.	World Bank
Average Hours Worked	Average annual hours worked by persons engaged	Penn World Table v9.1
Human Capital Index	Human Capital Index	Penn World Table v9.1
Productivity	Welfare-relevant Total Factor Productivity at constant prices (2011 =1)	Penn World Table v9.1

---

# Figures

## Undervaluation shocks on Economic Growth

Without covariates

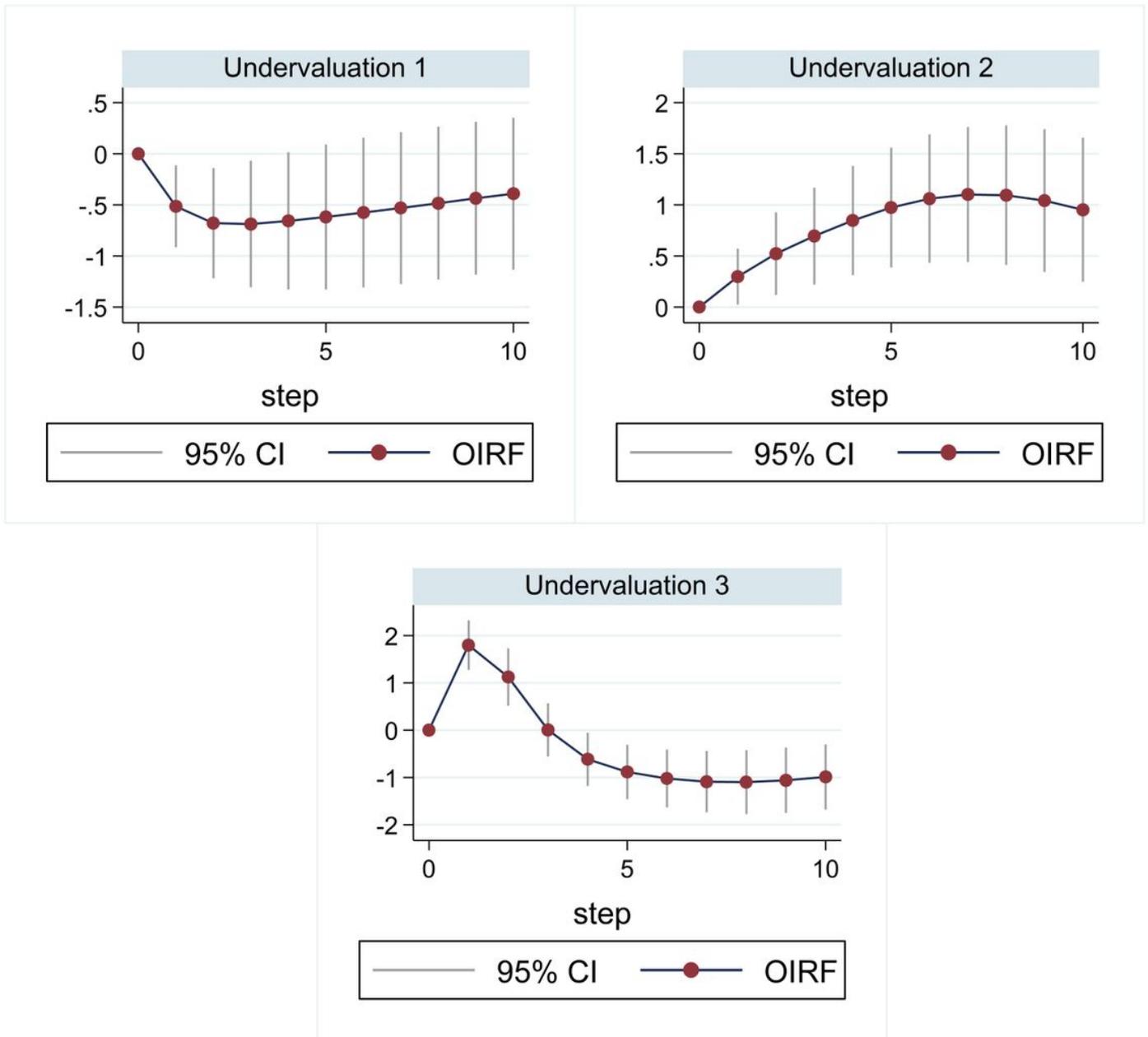


Figure 1

Shows that an undervaluation shock 1 causes a negative response from Economic Growth. An undervaluation 2 shock causes a persistent positive response in Economic Growth and, finally, an undervaluation 3 shock causes an increase in Economic Growth in the first period and then begins to decline.

# Undervaluation shocks on Economic Growth

Without covariates

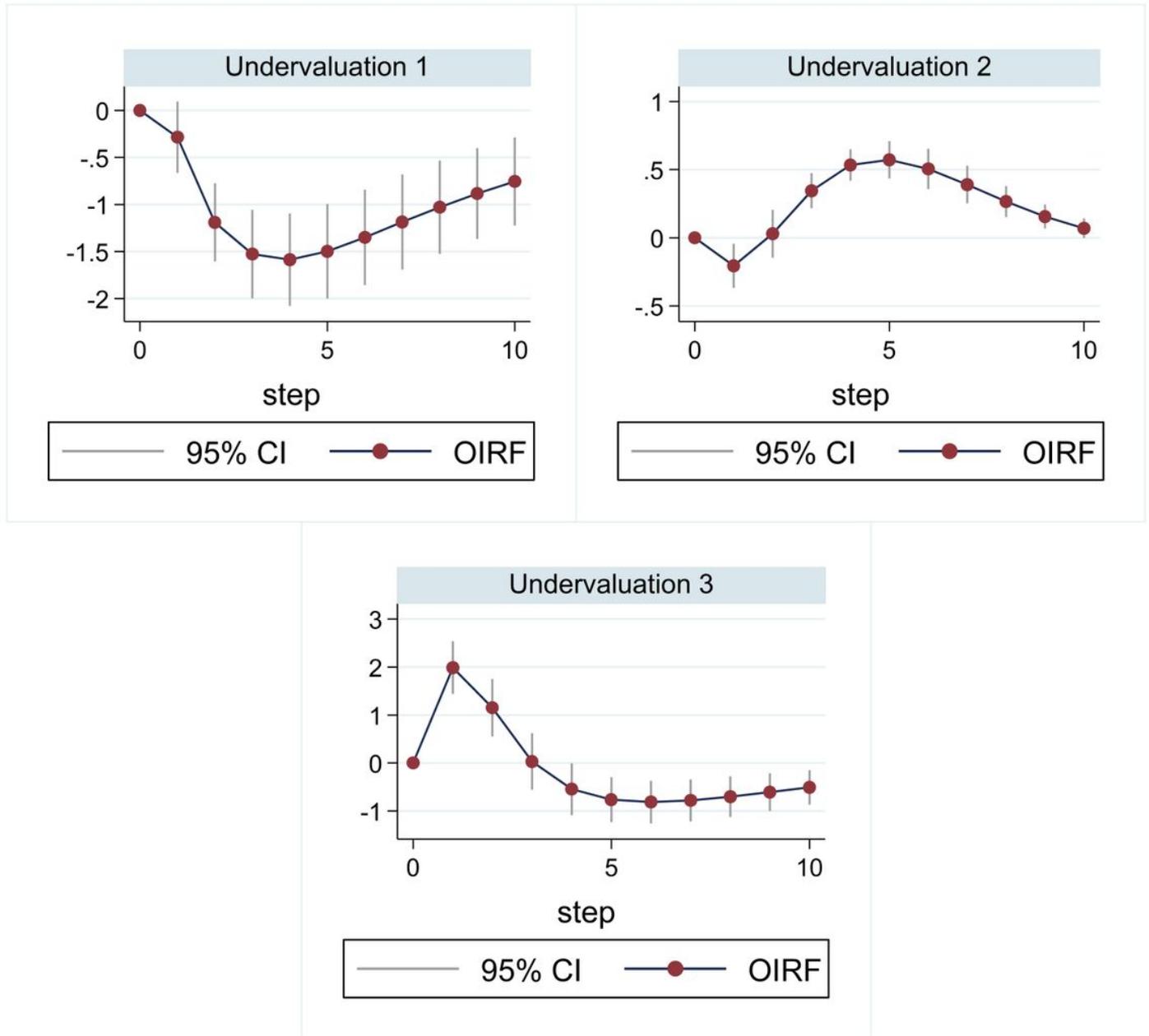


Figure 2

shows that a shock of undervaluation 1 causes a negative response of Economic Growth without bequeathing to recover, undervaluation 2 causes a fall of a period of Economic Growth and then begins to increase.

# Undervaluation shocks on Economic Growth

Without covariates

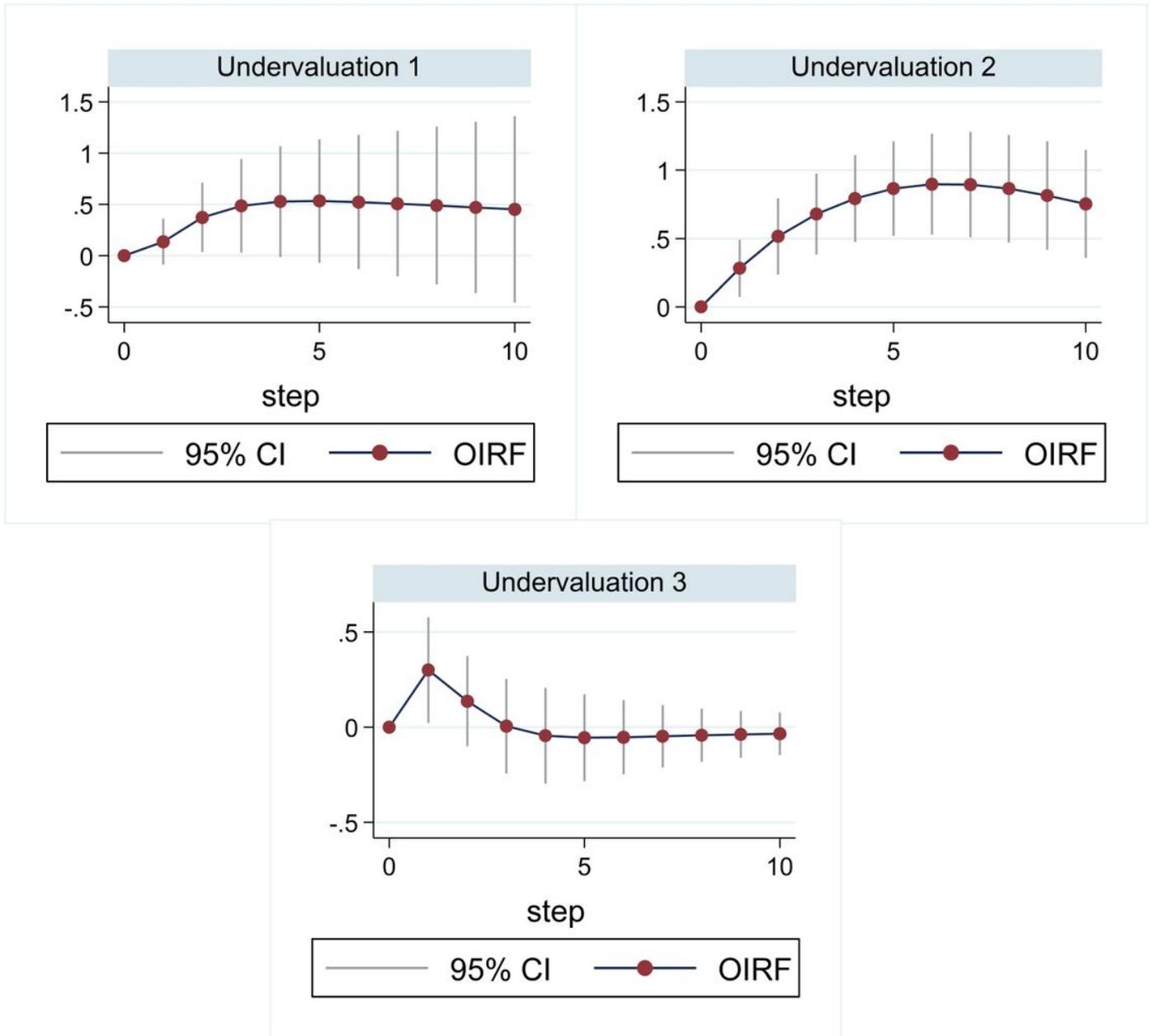


Figure 3

shows the impulse-response graphs using this measure of GDP per capita

# Undervaluation shocks on Economic Growth With Macroeconomic Covariates

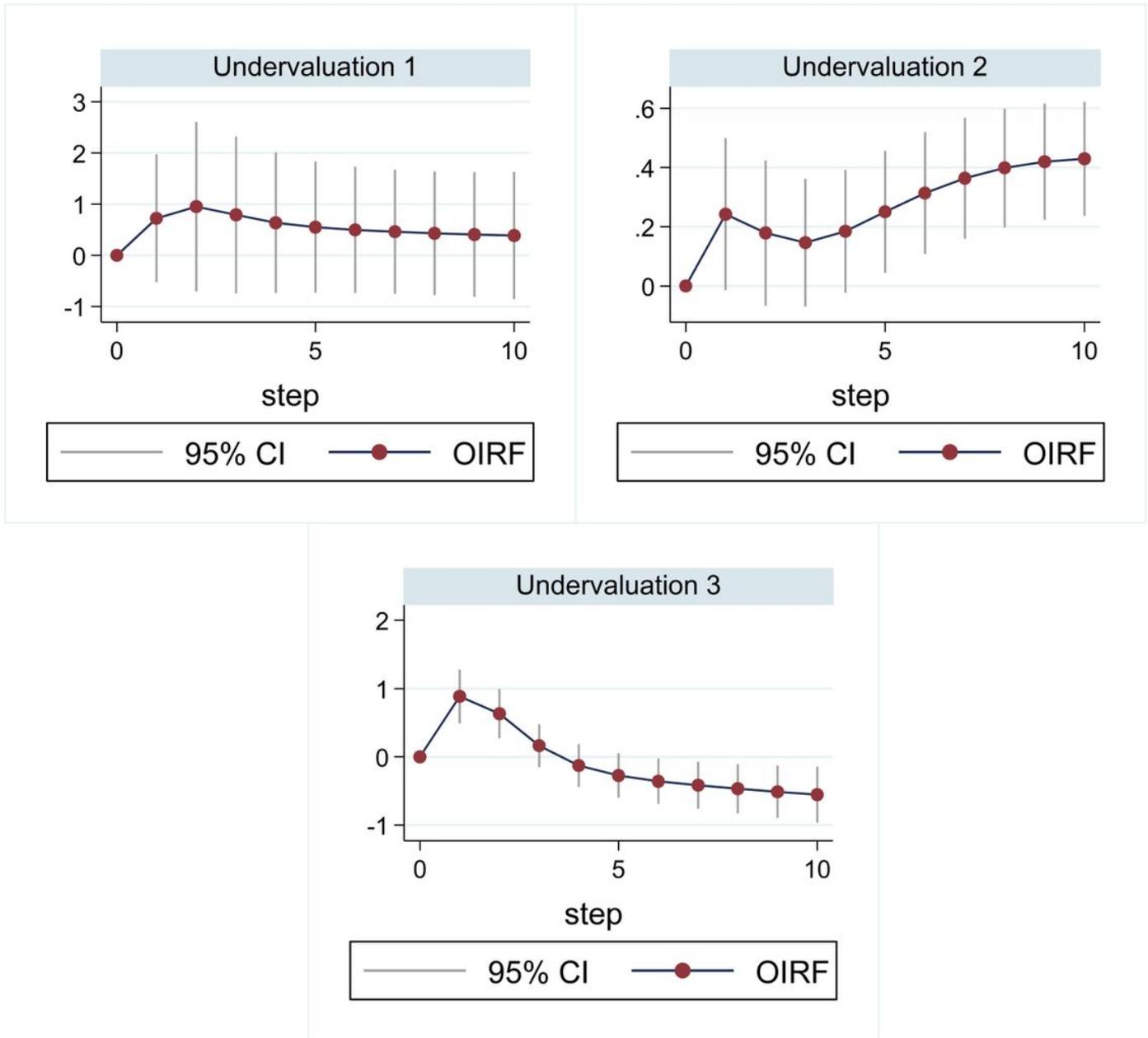


Figure 4

shows positive responses of Economic Growth to an undervaluation shock in all its measures. The first and third measures cause an increase in the first periods, but then decline while the second measure shows a persistent increase over time.

# Undervaluation shocks on Economic Growth With Macroeconomic Covariates

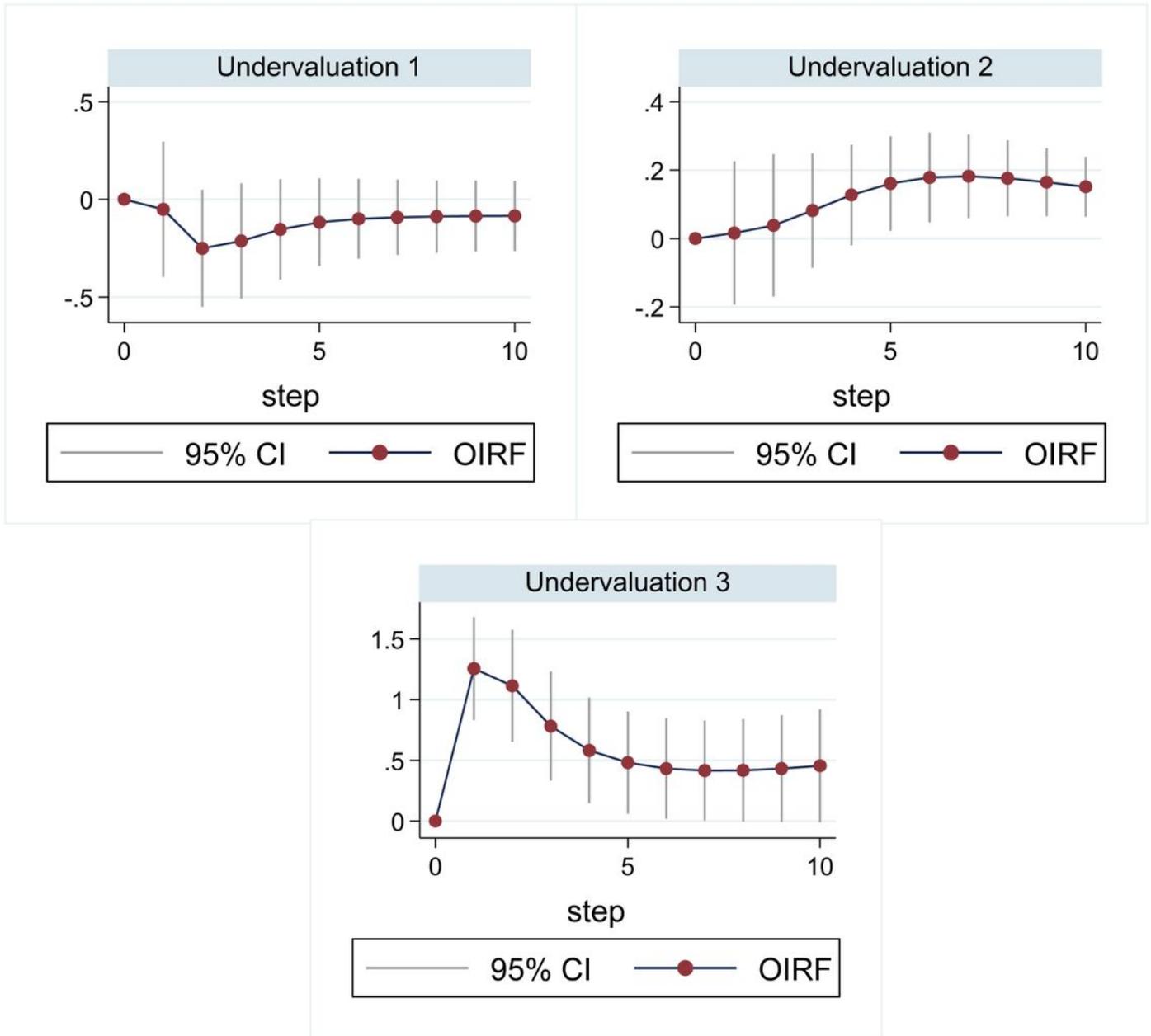


Figure 5

shows scattered results, a shock from the first undervaluation measure causes a drop in Economic Growth and then recovers without compensating for this effect. A shock from the second undervaluation measure causes persistent positive effects on Economic Growth while the last undervaluation measure causes an increase in the first period and then begins to decline, but without compensating for the impact.

# Undervaluation shocks on Economic Growth

## With Macroeconomic Covariates

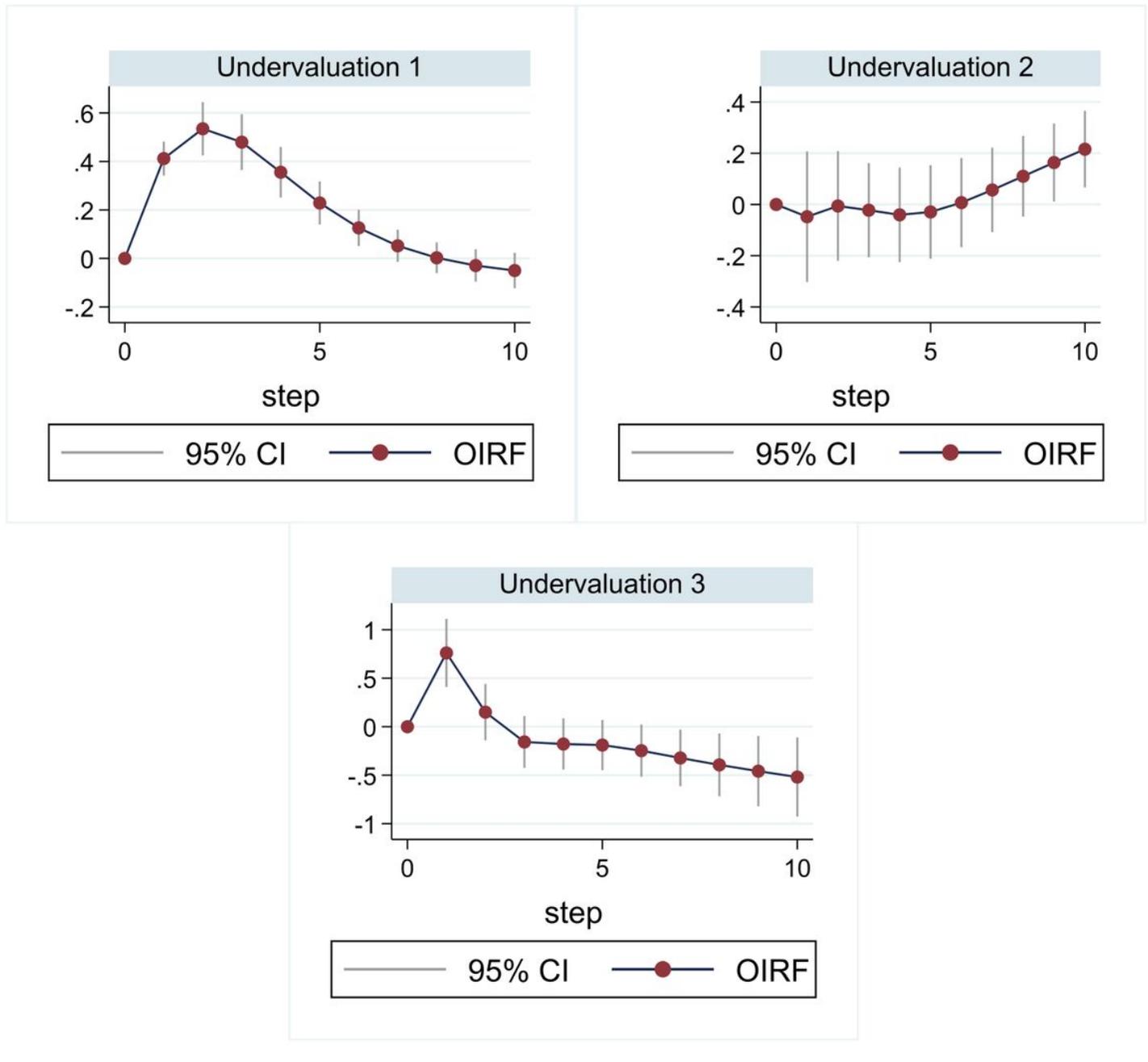


Figure 6

shows the impulse-response graphs, a shock of the first and second measures elicit a positive response from Economic Growth, while the second measure has no impact until the fifth period where it begins to increase. Once the results for this subsection have been presented, by way of conclusion, the third undervaluation measure finds positive impacts on Economic Growth, while the other measures show scattered results. Now, we move on to the third subsection, in which we include human capital variables such as average worked hours, human capital index and productivity.

# Undervaluation shocks on Economic Growth With Human Capital Covariates

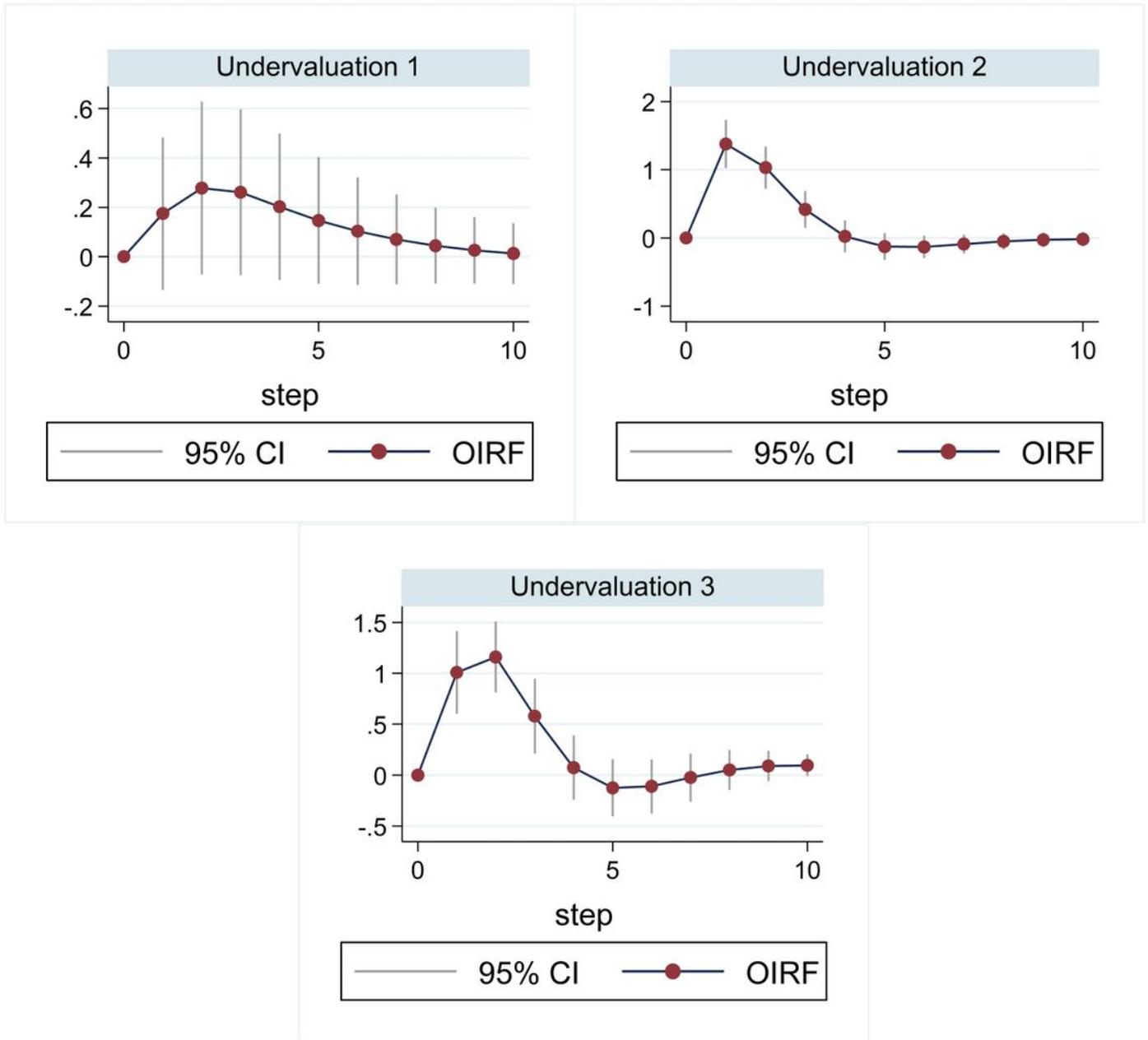


Figure 7

shows the impulse-impulse response graphs of all undervaluation measures on Economic Growth.

# Undervaluation shocks on Economic Growth With Human Capital Covaariates

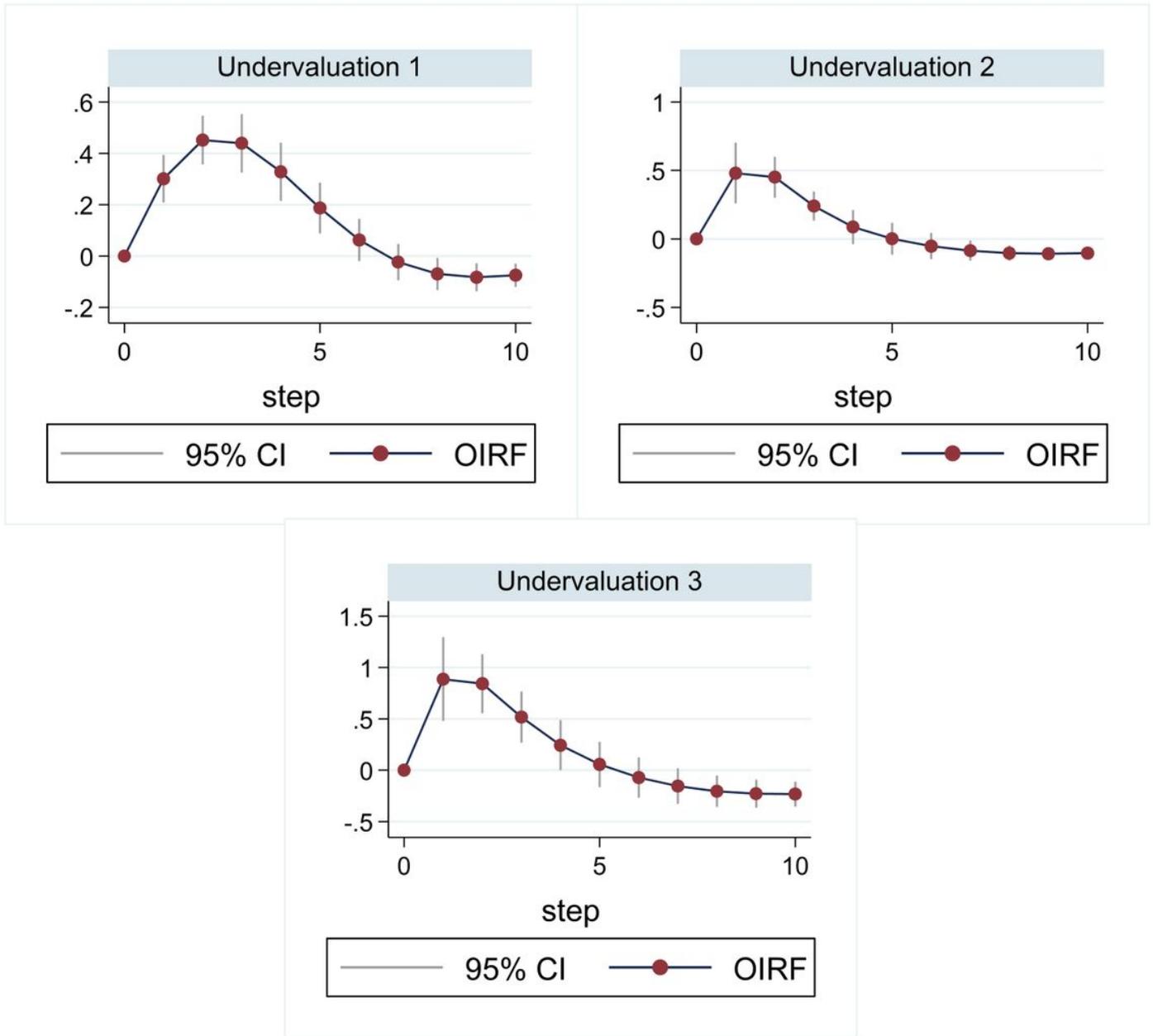


Figure 8

show that the three undervaluation measures provoke a positive response in the Economic Growth until the third period and then begin to decrease below zero.

# Undervaluation shocks on Economic Growth

## With Human Capital Covaariates

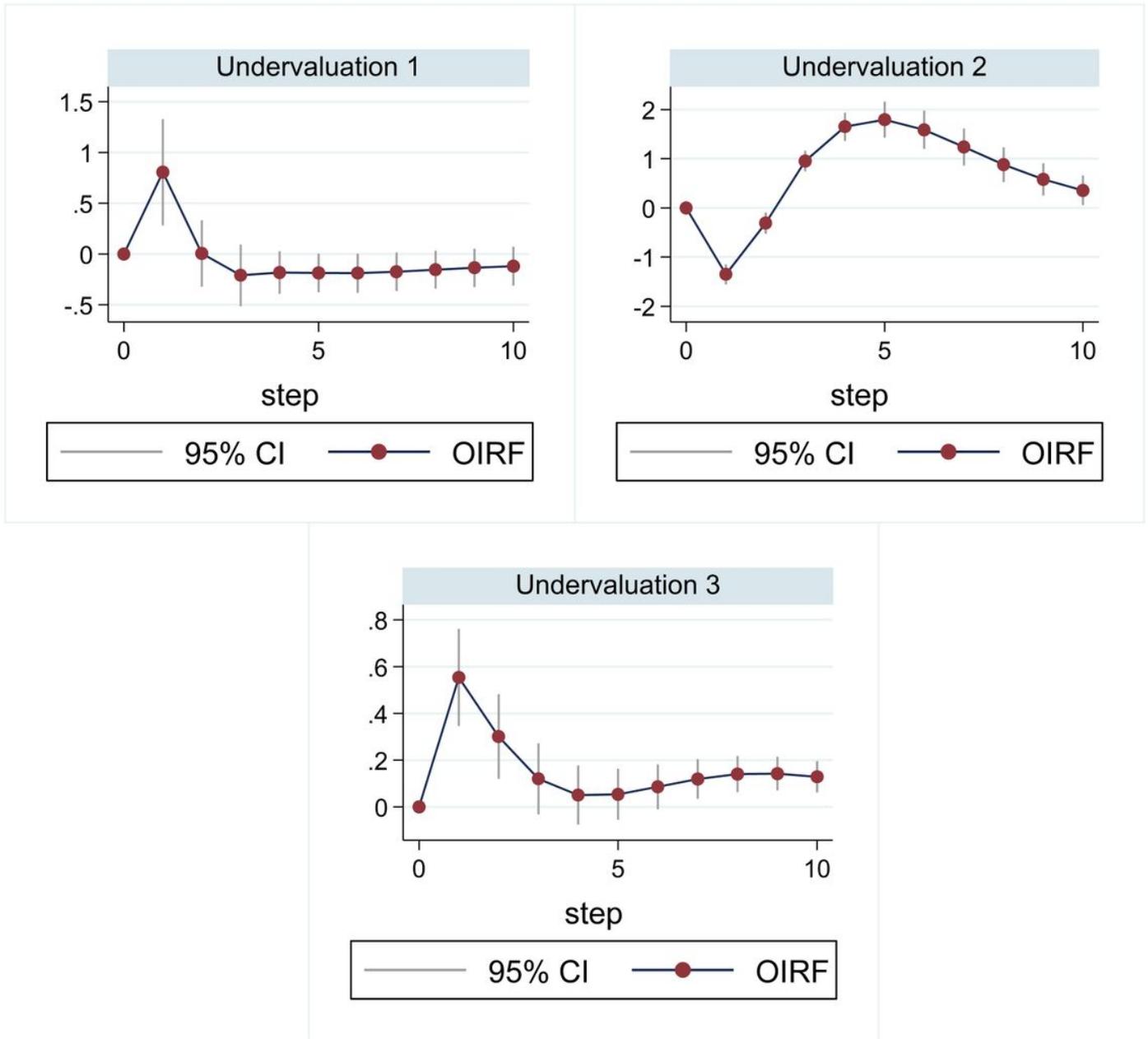


Figure 9

shows the impulse-response graphs.

# Undervaluation shocks on Economic Growth

## With All Covariates

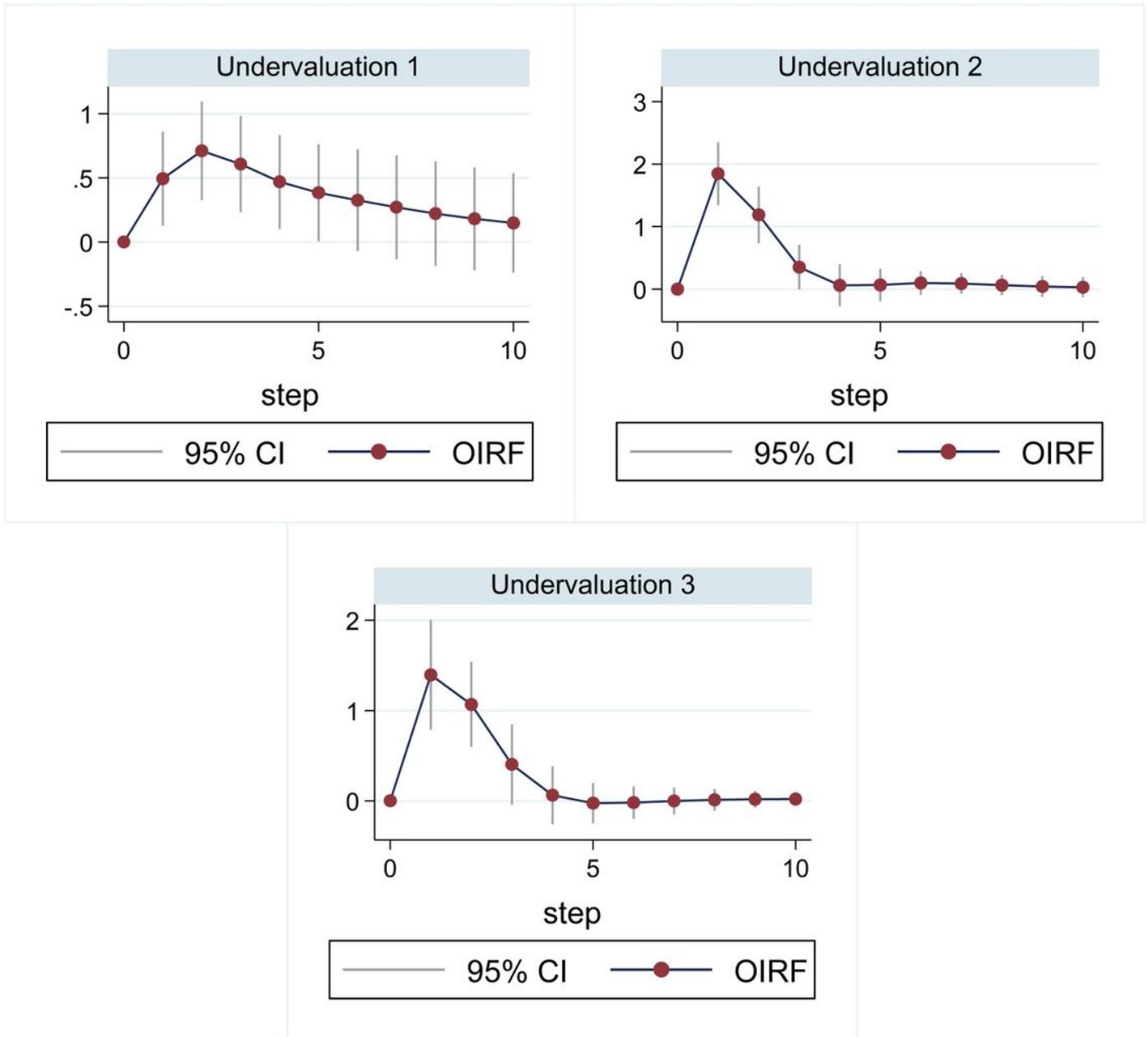


Figure 10

shows that a positive shock from Undervaluation positively impacts Economic Growth, but the second and third measures are compensated until the fourth period for both, while the first measure is not compensated in the first 10 periods

# Undervaluation shocks on Economic Growth

## With All Covaariates

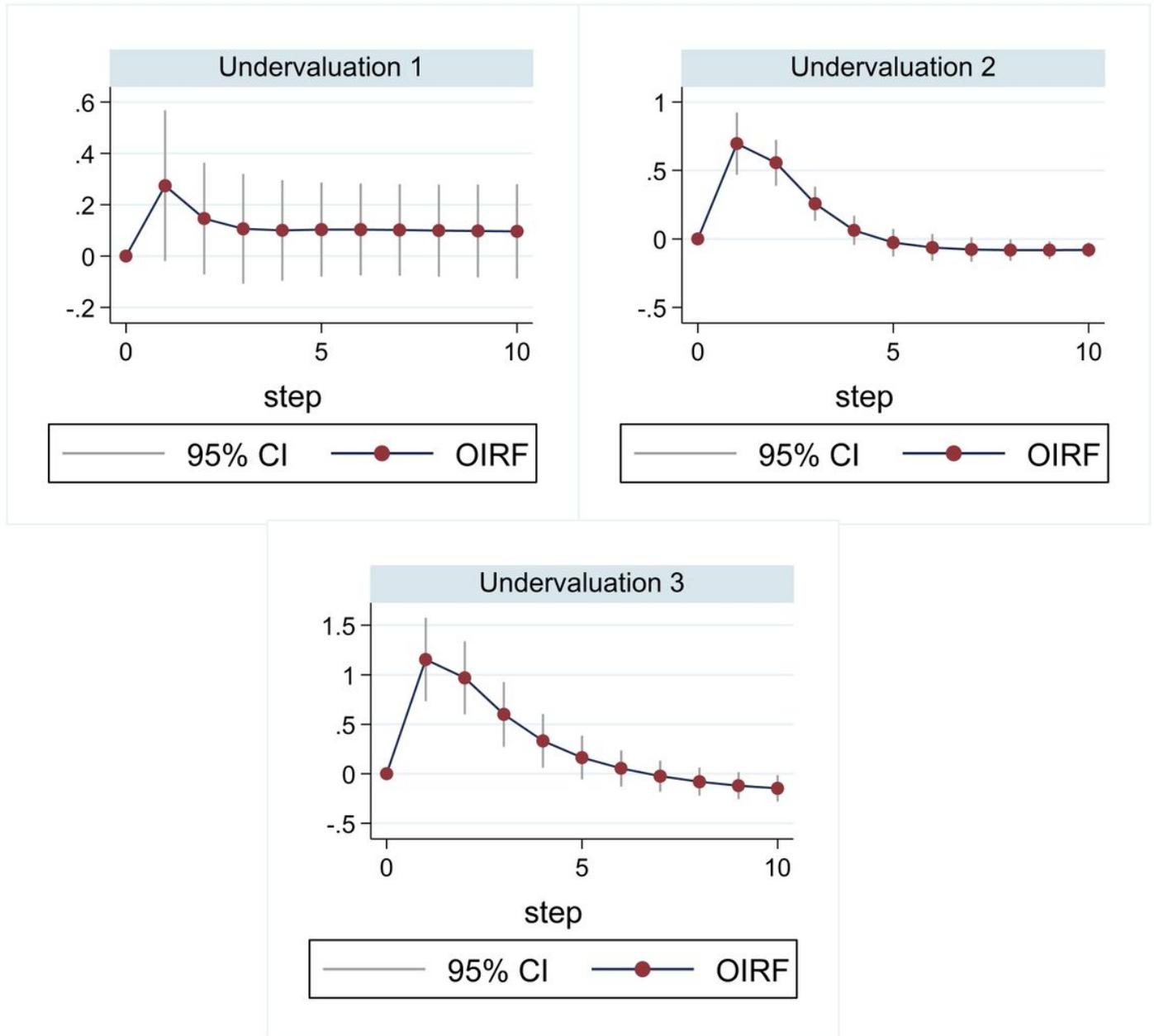
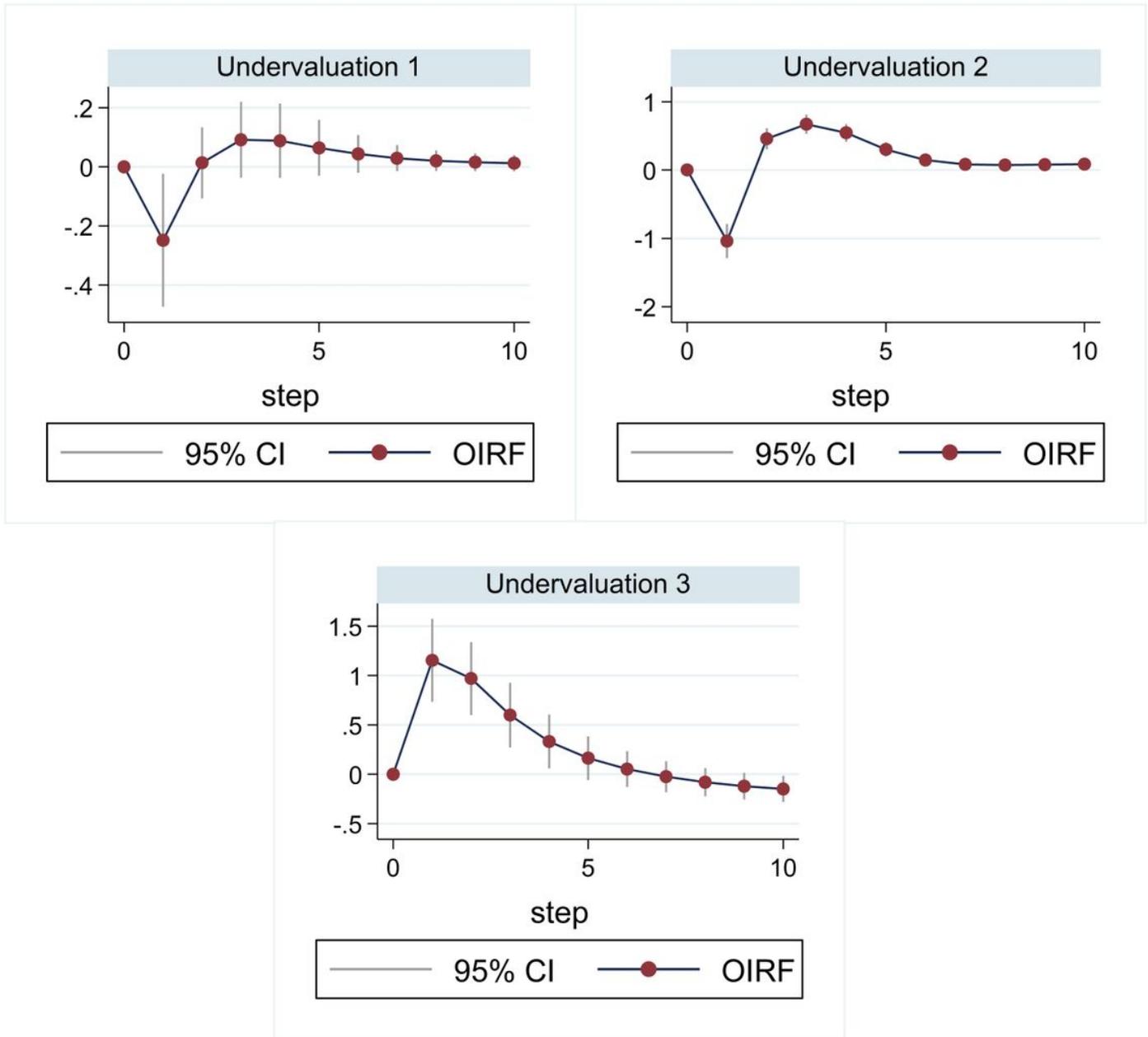


Figure 11

shows that a shock of all undervaluation measures causes an increase in Economic Growth, only the second and third measures are offset by reaching zero, while the first measure remains constant in all periods.

## Undervaluation shocks on Economic Growth With All Covariates



**Figure 12**

shows that the first and second undervaluation measures have negative impacts on the Economic Growth while the third measure has positive impacts increasing in the first period and then falling to below 0. So, the results of this section that only the third measure of undervaluation shows positive effects on all measures of GDP per capita, while the other measures show scattered results. In the next section, we present the conclusions of this study, and in the annex we present the Granger causality tests of all the estimates made in this investigation.