

INVESTIGATING THE DETERMINANTS OF BIG MAC INDEX: A PANEL DATA ANALYSIS

Hrvoje JOŠIĆ

University of Zagreb, Faculty of Economics & Business, Kennedy sq 6, Zagreb, Croatia
hjosic@efzg.hr

Zoran WITTINE

University of Zagreb, Faculty of Economics & Business, Kennedy sq 6, Zagreb, Croatia
zwittine@efzg.hr

Antea BARIŠIĆ

University of Zagreb, Faculty of Economics & Business, Kennedy sq 6, Zagreb, Croatia
abarasic@net.efzg.hr

Abstract

Noted by several researchers, Law of One Price (LOOP) and Purchasing Power Parity (PPP) do not stand for most of the products in the short and long run. It is important to investigate what stands behind it, besides some specific additional costs that could lead to different results. Our goal is to check whether there are any general determinants that significantly affect the valuation. The oldest informal measure of PPP, Big Mac Index, created by The Economist in 1986, will be calculated to show absolute and relative parity valuation of currencies around the world. By using cross-country panel data analysis on the sample of 25 countries in the period from 2000 to 2015, main determinants of Big Mac index are investigated. The results of the analysis have shown that deviations from the parity can be explained by current account variable while other independent variables representing main determinants of Big Mac index were not significant. Furthermore, results of the analysis indicate that relative PPP does not hold in the long run.

Keywords: Big Mac index, valuation, panel data.

JEL code: F31

Introduction

Purchasing power parity (PPP) is a theory which states that national price levels should be equal after converted to a common currency. It has origins in a Law of one price (LOOP). Karl Gustav Cassel (1918) was the originator of idea behind the PPP theory and the most credited economist in this field at his time. Unlike PPP theory LOOP considers only one identical good. PPP comes in two varieties; absolute and relative version. Absolute purchasing power parity takes into account prices of goods in two countries which should reflect exchange rates between countries. Relative purchasing power parity is a dynamic version of absolute purchasing power parity which predicts relationship between exchange rate differential and inflation rates between two countries in observed time period. Light-hearted measures of Law of One Price (LOOP) and Purchasing Power Parity (PPP) such as Big Mac Index, KFC Index, Starbucks index and lately Apple indices are promoted to be a way to come across the fact that consumer basket around the world not always includes the same products, as a result of bias toward different goods across countries. The Economist's Big Mac Index was first published in 1986. It is informal way of measuring the purchasing power parity (PPP) between two currencies. It compares Big Mac prices between countries based on the purchasing power parity theory using Big Mac (McDonald's burger) for comparison. Although Apple indices as newly emerging informal measures of PPP show several benefits (Jošić and Barišić, 2017), Big Mac index has one very important advantage and we must not put it aside so easily. The product itself is one of the rarest examples of non-changing product over long period of time, present in wide range of countries across the globe, making it possible to check the determinants leading to its deviations from the parity and thus investigating what could lead the changes. Also, when comparing aforementioned equal product prices not rarely the analysis gives opposing results, pointing to currency

undervaluation and overvaluation at the same time, depending on the chosen index. It is important to investigate what stands behind it, besides some specific additional costs that could lead to different results. Our goal is to check whether there are any general determinants that significantly affect the valuation. Using cross-country panel data on the sample of 25 countries in the period from 2000 to 2015 this paper analyzes the effects of explanatory variables (gross domestic product per capita, current account balance, general government balance, labor compensation representing average wages and Index of economic freedom) on Big-Mac absolute parity as dependent variable. In addition, relative parity for the Big-Mac index is calculated while panel unit root tests are used in order to investigate whether relative parity holds in the long run. Paper is organized in five chapters. After the introduction, the second chapter gives research overview on Big Mac index determinants. Methodology and data are explained in the third chapter while fourth chapter displays empirical analysis, results and discussion. Final chapter exhibits concluding remarks.

Research overview of Big Mac index determinants

In this chapter main determinants of Big Mac index are presented and explained. Some of them can also be looked as limitations why PPP does not hold. Pakko and Pollard (1996) explained deviations from PPP considering three main explanations: the existence of barriers to trade, inclusion of non-traded elements in the cost of a Big Mac production and pricing to market. Types of barriers to trade are transportation costs, trade restrictions and taxes. Transportation costs drive a wedge between the prices of Big Mac ingredients in different places. More important factor are trade restrictions such as imposition of tariffs and quotas on trade of agricultural products which increase the price of imports. Price of Big Mac hamburger is inclusive of sales or value added taxes so differences in tax systems across countries lead to differences in Big Mac parities. However, price of Big Mac does not depend only on price of its ingredients but also on the cost of real estate and utilities needed in the process of Big Mac production. There is also a service component or wages paid to workers for preparing the meal and serving the customers which also belongs to non-trading component. Although, according to Balassa (1964), non-traded goods affect the deviations from PPP due to differences in productivity across countries, there are unlikely large differences in productivity of workers in preparing Big Macs in different locations. Government expenditures and current account imbalances can also explain why Big Mac parities does not hold between countries in various periods. Another reason for PPP not to hold is pricing to market or charging different prices on different markets. Pakko and Pollard (2003) explained that in the presence of imperfect competition prices of traded goods may differ. Firms can price to market by limiting exchange-rate pass-through and the ability to price to market depends on safety and pollution standards, warranty restrictions and other factors that affect the possibility to resold goods across national borders. According to Haidar (2011) main methodological limitations of the BMI are demand variability, product comparability, exchange rate predictability, elements non-tradability, transportation costs, trade restriction, taxes, productivity differentials, government expenditures and current account deficits and pricing to market. Alessandria and Kaboski (2011) argue that pricing to market is important as any local non-traded inputs, such as distribution costs. In explaining the differences in tradable prices across countries they propose a model of consumer search that generates pricing-to-market. O'Brien and de Vargas (2015) and Clements and Si (2016) highlighted the importance of taking GDP into account when assessing currency valuation. This is done by expressing Big Mac prices as a function of GDP per capita and adjusting for differences in incomes of countries by constructing adjusted BMI. Adjusted BMI accounts for prices being cheaper in poorer countries and vice versa. Aforementioned authors found that adjusted BMI outperforms the „Raw“ (the Economist's) index in forecasting future currency values. Bat-Ulzii (2016) used human development index, considered as a good measurement of overall welfare of the economy, in evaluating BMI. Human Development Index had a positive correlation with the Big Mac Index indicating that the more the country is developed the more a Big Mac burger costs at the same time rejecting the BMI measurement of currency valuation.

Methodology and data

Absolute purchasing power parity valuation represents deviations from purchasing power parity. If deviations are positive, local currency is overvaluated against the USD, otherwise local currency is undervaluated. Absolute valuation for Big Mac index is calculated using equation 1:

$$100 \cdot \left((P_{bm} / P_{bm}^*) (1 / E) \right) - 100 \quad (1)$$

where P_{bm} is local price of Big-Mac hamburger in domestic currency, P_{bm}^* is USD price of Big-Mac hamburger in United States while E is nominal exchange rate. Relative purchasing power parity is a dynamic

version of the absolute purchasing power parity. It is less strict than the absolute version and states that the percentage change in consumer prices in both countries should imply the same change in the foreign exchange rate at the same time. In equation 2 is presented formula for calculation of relative PPP calculation for BMI:

$$\left(\% \Delta P_{bm} - \% \Delta P_{bm}^* \right) - \% \Delta E \quad (2)$$

Another way of expressing relative PPP is using base year for which the PPP holds (equation 3).

$$\frac{(E_t - E_{baseyear})}{E_{baseyear}} = \frac{(P_{bm,t} - P_{bm,baseyear})}{P_{bm,baseyear}} - \frac{(P_{bm,t}^* - P_{bm,baseyear}^*)}{P_{bm,baseyear}^*} \quad (3)$$

Big Mac affordability is calculated using equation 4. It represents the number of Big Mac hamburgers that can be daily bought with country's GDP per capita. GDP per capita and price of Big Mac in country j have been expressed in USD.

$$BM_{afford.} = \frac{GDP_j}{(BM_{price})_j} / 365 \quad (4)$$

In order to investigate main determinants that affect the absolute valuation of national currencies against the dollar, panel regression model is formulated including 25 countries in the period from 2000 to 2015. Explanatory variables in the analysis are gross domestic product, current account, labour compensation, general government balance and index of economic freedom. Other variables such as productivity and barriers to trade (transportations costs, trade restriction and taxes) were not included in the analysis. It is unlikely there are larger differences in productivity of workers in baking hamburgers in McDonald's across the world. Furthermore, Big Mac is a non-traded good so barriers to trade should not have effect the final price of a product¹. Data for regression are calculated or provided from various Internet sources. Proposed cross-country panel regression model is formulated as follows:

$$VALUATION = \beta_0 + \beta_1 GDP_i + \beta_2 CA_i + \beta_3 LABCOMP_i + \beta_4 GGB_i + \beta_5 IEF_i \quad (5)$$

VALUATION - variable denoting the percentage of overvaluation or undervaluation of national currency relative to USD. Positive values of variable *VALUATION* denotes percentage of overvaluation while negative values denotes undervaluation of national currency against the USD².

GDP_i - Gross Domestic Product per capita (USD constant prices 2010 PPPs) of country i .³

CA_i - variable representing current account balance expressed as a percentage of GDP country i .⁴

LABCOMP_i - labour compensation per capita country i .⁵

GGB_i - general government balance expressed as a percentage of GDP country i .⁶

IEF_i - Index of economic freedom country i .⁷

¹ If analysis was conducted on Big Mac ingredients used in the production of the final product then this variable would matter.

² Data are available from the web page <http://www.economist.com/content/big-mac-index>. In the period from 2012 to 2016 the data are published semi-annually, for January and July, which was chosen in the analysis.

³ Data are available from the web pages <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD> and <http://stats.oecd.org>.

⁴ Data are available from the web pages <http://data.worldbank.org/indicator/BN.CAB.XOKA.GD.ZS> and <http://stats.oecd.org>.

⁵ Labour compensation per capita is calculated using variable *labsh* (share of labour compensation in GDP at current national prices) from Feenstra, Robert C., Robert Inklaar and Marcel P. Timmer (2015), "The Next Generation of the Penn World Table" American Economic Review, 105(10), 3150-3182, available for download at www.ggd.net/pwt multiplied with national GDP (in USD, 2010 constant prices). This variable was chosen into analysis instead of variable wages because full data series for variable wages was not available and could not be constructed.

⁶ Data are available from the web pages <https://data.oecd.org/gga/general-government-deficit.htm> and <http://stats.oecd.org>.

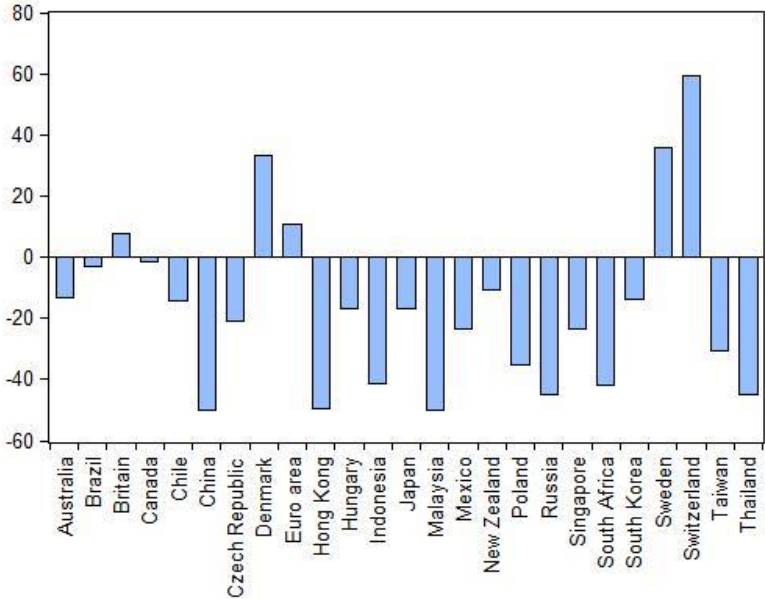
⁷ This variable was chosen to describe imperfect competition or unmeasurable effects of pricing to market variable like warranty restriction, resale probability, safety standards, business regulators, pollution criteria, wholesale, etc.

Expected signs of regression are positive for variables GDP_i , CA_i and $LABCMP_i$ and negative for variables GGB_i and IEF_i . It is expected that higher value of gross domestic product per capita is positively correlated with Big Mac prices and consequently overvaluation of national currencies against the USD. Similarly, the differences between wages (labour compensation) for workers in different countries may explain why some currencies are under/over valued against the USD. Developed economies tend to give higher wages to their workers so their national currencies should be overvaluated against the dollar as measured by Big Mac prices. Researchers have generally failed to find a statistical relationship between exchange rate movements and current account imbalances. It can go either way, be positive or negative so it is difficult to conclude about direction of this effect (Pakko and Pollard, 1996). On the other side, increased government spending rise the overall price level and consequently national currency will be overvaluated relative to its PPP level. Higher value of index of economic freedom should be associated with easier doing business and therefore lower prices and undervaluation of national currencies against the USD. Cross-country panel regression model will be conducted differentiating between Pooled OLS (POLS), Fixed effects (FE) and Random effects (RE). In order to choose between fixed effects and random effects model Hausman test will be used while redundant fixed effects (Likelihood ratio) test will be used to differentiate between POLS and FE model. In addition, panel unit root tests will be used to investigate if relative purchasing power parity holds in the long run.

Results and discussion

In Table 1 (Appendix) is presented calculation of absolute purchasing power parity valuations for 25 countries (including Euroarea) for the period from 2000 to 2016. It can be seen that the most of the national currencies were undervaluated against the USD. In the year 2000 overvaluated national currencies were British pound, Danish krone, Japanese yen, South Korean won, Swedish krona and Swiss franc while in 2016 only Swedish krona and Swiss franc were overvaluated against the USD. Relative purchasing power parity valuation for selected countries in the period from 2001 to 2016, 2000 chosen as the base year, is presented in Table 2 (Appendix). Calculation is made using equation 3. Average country's Big Mac absolute PPP valuation is presented in Figure 1.

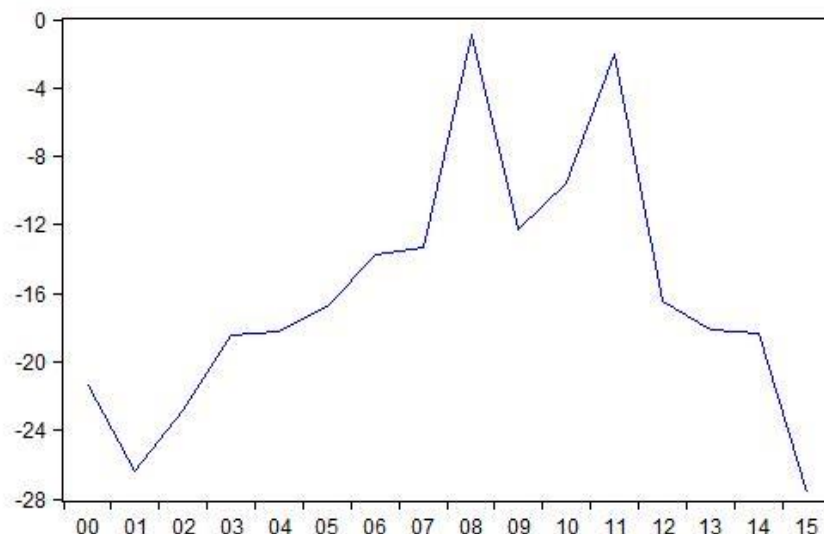
Figure 1: Average country's Big Mac absolute valuation, 2000-2015



Source: Authors' calculations

It can be noticed average undervaluation of national currencies relative to USD in most countries in the observed period. Overvaluation was present only in Britain, Denmark, euro area, Sweden and Switzerland.

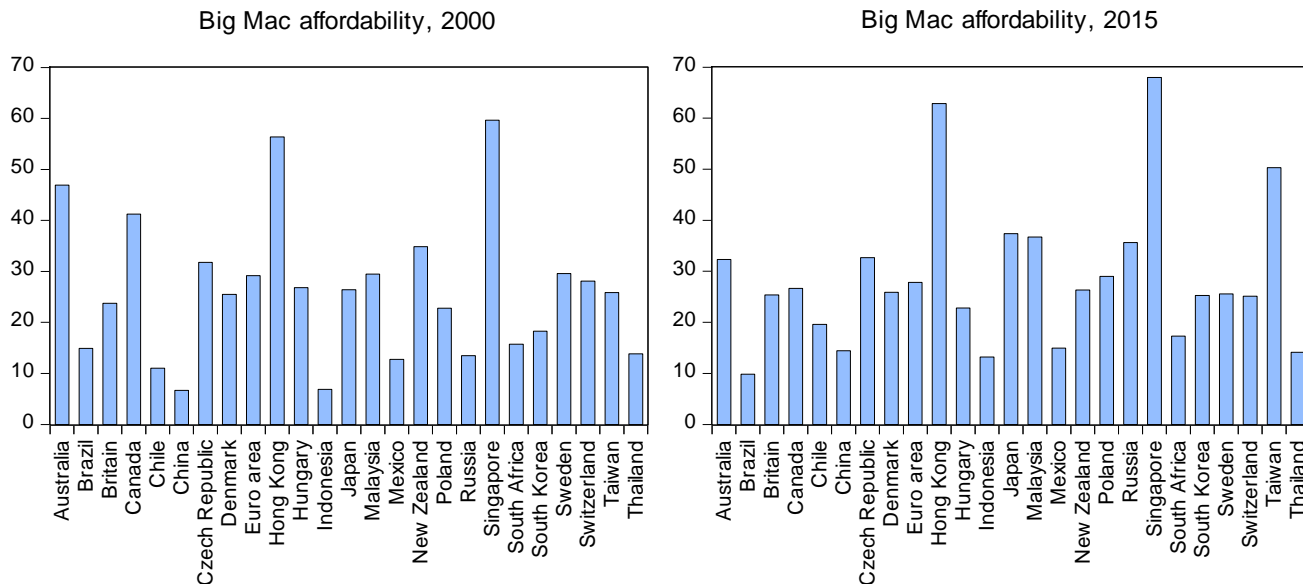
Figure 2: Average annual currencies' absolute valuation relative to USD, 2000 to 2015



Source: Authors' calculations

Average annual currencies' absolute valuation relative to USD from 2000 to 2015 is displayed in the Figure 2. Throughout the observed period there can be seen average currencies' absolute undervaluation against the USD with maximum value of -27.66% in 2015. Conversely, in the years 2008 and 2011 average absolute valuation is minimal and PPP nearly holds.

Figure 3: Big Mac affordability, 2000 and 2015



Source: Authors' calculations

Figure 3 displays Big Mac affordability in years 2000 and 2015. In the year 2000 the most Big Mac hamburgers could be daily bought in Singapore (59), Hong Kong (56), Australia (46) and Canada (41) while customers from China and Indonesia could purchase only 6 Big Macs daily. In the year 2015 alongside Singapore (68) and Hong Kong (62), the most hamburgers is affordable daily in Taiwan (50) while Brazil is at the end of the ladder with only 9 hamburgers to purchase daily. Table 3 exhibits descriptive statistics of variables absolute PPP valuation (expressed in percentages, %), gross domestic product (in USD), current account balance (in % of national GDP), general government balance (in % of national GDP), labour compensation and Index of economic freedom (annual index in range of maximum value 100 and minimum value 0).

Table 3: Descriptive statistics of variables, 25 countries, 2000-2015

Variable	Absolute PPP valuation,%	Gross domestic product p.c.	Current account balance, %	General government balance, %	Labuor compensation	Index of economic freedom
Mean	-16.02772	26,947.86	2.332115	-1.283538	14,928.46	69.94
Median	-21.70225	26,216.46	1.454479	-1.300000	14,596.65	69.60
Maximum	98.35217	85,382.30	26.10381	12.00000	40,090.68	90.10
Minimum	-64.26071	2,933.31	-8.532925	-10.20000	1,757.93	48.70
Std. Dev.	31.51329	15,003.12	6.308501	3.491282	8,495.90	10.12847
Skewness	1.023919	0.806623	1.000494	0.386786	0.470124	0.003404
Kurtosis	3.680713	3.878130	4.104020	3.911250	2.567026	2.403498
Jarque-Bera	77.61686	56.22791	87.04696	23.81315	17.85890	5.931022
Sum	-6,411.088	10,779,146	932.8460	-513.4150	5,971,383.	27,977.43
Sum Sq. Dev.	396,241.90	8.98E+10	15879.08	4,863.43	2.88E+10	40,931.77
Observations	400	400	400	400	400	400

Source: Authors' calculations

Absolute PPP valuation mean is -16.02 indicating that average absolute PPP valuation is negative meaning undervaluation of national currencies against the USD (as seen on Figure 2). Median amounts at -21.7, maximum value is 98.35 (for Switzerland in 2011) and minimum value is -64.26 (for South Africa in 2002). Gross domestic product per capita mean is 26,947.86 and median is 26,216.46. Maximum value of GDP per capita was reported for Singapore in 2015 (85,382.30) while minimum value is 2,933.31 (China in 2000). Current account mean is positive (2.33), as its median (1.45). Highest current account suficit was reported in Singapore in 2007 with 26.10 percent while highest current account deficit was present in Hungary in 2004 with -8.53 percent of GDP. On the other side, general government balance mean is negative (-1.28) as well as median (-1.30). Highest general government suficit was present in Singapore in 2007 with 12 percent while highest deficit were recorded in Britain and Brazil with -10.2 percent in 2015 and 2009 respectively. Labour compensation mean and median amount at 14,928.46 and 14,596.65. Maximum value was present in Switzerland in 2014 (40,090.68) and minimum value was in China in 2000 (1,757.93), similarly as it's GDP per capita values. Country with highest value of Index of economic freedom was Hong Kong (90.1 in 2014). On the other side, lowest Index of economic freedom had Russia (48.7 in 2002). Results of the cross-country panel regression analysis for 25 countries in the period from 2000 to 2015 are presented in Table 4. Panel is balanced with 400 observations included. Dependant variable is VALUATION while independant variables are LAB_COMP, GDP, GGB, CA and IEF. In order to differentiate between POLS, Fixed effects and Random effects models, Hausman test for correlated random effects and Likelihood ratio test for redundant fixed effects are used.

Table 4: Cross-country panel regression, 25 countries, 2000 - 2015

Dep. var. VALUATION			
Independent variables	POLS	FE	RE
Constant	-49.34534 (11.18161)	-40.49788 (26.00752)	-53.30419 (20.35061)
LAB_COMP	0.006080*** (0.000545)	0.001298 (0.001207)	0.003018*** (0.001001)
GDP	-0.002339*** (0.000361)	-0.000447 (0.000634)	-0.001264*** (0.000536)
GGB	0.985063*** (0.371096)	-0.006836 (0.305335)	0.131939 (0.299670)
CA	-0.631877*** (0.236995)	-0.593653** (0.280918)	-0.478926* (0.263559)
IEF	0.119208 (0.193613)	0.264681 (0.390597)	0.394179 (0.305355)

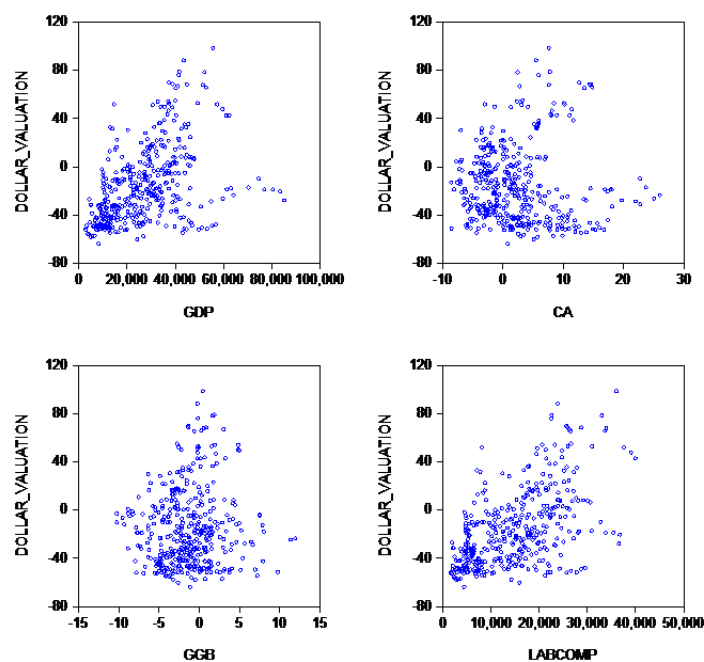
Adjusted R-squared	0.438341	0.800463	0.0057324
S.E. of regression	23.61729	14.61812	14.74239
Prob. (F-statistic)	0.00000	0.00000	0.00000
Mean dependent variable	-16.02772	-16.02772	-16.02772
S.D. dependent variable	31.51329	31.51329	31.51329
Akaike info criterion	9.176722	8.274439	-
Durbin -Watson stat	0.262755	0.690616	0.642111
Observations	400	400	400
Redundant fixed effects (Likelihood ratio)	Cross-section F (27.434477), Prob. (0.0000) Cross-section Chi-square (408.913261), Prob. (0.0000)		
Correlated random effects (Hausman test)	Chi-Sq. Statistic (11.727346), Prob. (0.0387)		

Source: Authors' calculations

OLS estimates show White heteroskedasticity- consistent standard errors and covariances; *t*-statistics in parentheses; significant at the 1 percent level: ***, at the 5 percent level: **, at the 10 percent level: *.

Hausman test is used in order to choose between fixed effects and random effects model. The null hypothesis states that preferred model is random effects while the alternative hypothesis states the opposite. The value of Chi-Square statistic for Hausman test is 11.727346 with probability of 0.0387 indicating that fixed effect model is preferable over random effects model. Likelihood ratio test's cross-section Chi-square statistic is 408.913261 and Cross-section F value is 27.434477 under 0.05 probability indicating that fixed effects model is preferable over pooled OLS. Fixed effects model is not redundant suggesting that POLS hide the heterogeneity among the cross-section data. Statistically significant independent variable in regression is current account under 5 percent level of significance. Other independent variables are not significant in the model under 10% of significance.

Figure 4: Absolute valuation vs Big Mac determinants graph



Source: Authors' calculations

Scatter diagram for absolute valuation versus Big Mac determinants (GDP, CA, GGB and LABCOMP) graph is presented in Figure 4. Values of absolute valuation are dispersed over the diagram so no clear conclusion could

be made about relationship between absolute valuation and its determinants. Relative purchasing power parity will be tested with the help of panel unit root tests which estimate the stationarity of the process. In Table 5 is given summary of panel unit root tests. Null hypothesis assumes common unit root process while the alternative hypothesis states the opposite. If there is common unit root process, then relative PPP holds.

Table 5: Summary of panel unit root tests

Series: Relative parity Exogenous variables: Individual effects, individual linear trends Automatic selection of maximum lags Automatic lag length selection based on SIC: 0 to 2 Newey-West automatic bandwidth selection and Bartlett kernel				
Method	Stat.	Prob.	Cross-sections	Obs.
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t	-415.594	0.0000	25	371
Breitung t-stat	303.219	0.9988	25	346
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	0.30198	0.6187	25	371
ADF - Fisher Chi-square	511.115	0.4298	25	371
PP - Fisher Chi-square	449.876	0.6743	25	375

Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution. All other tests assume asymptotic normality.

Source: Authors' calculations

Majority of panel unit root tests suggested that series of relative parity is stationary process although Levin, Lin and Chu test pointed out to the opposite conclusion. Values of relative purchasing power parity does not bounce back to their equilibrium levels so relative purchasing power parity does not hold in the long run. It can be concluded that there is no clear evidence in favour of accepting the validity of main determinants of Big Mac index. Further investigation should be made taking into account possible endogeneity in some of regressors and constructing dynamic panel data specification model.

Conclusions

Goal of the paper was to check whether there are any general determinants that significantly affect the valuation of Big Mac index. Firstly, absolute and relative purchasing power parity valuations for 25 countries (including Euroarea) in the period from 2000 to 2016 were calculated. Results of the analysis point out to the conclusion that the most of national currencies were undervalued against the USD in the observed period. In order to investigate main determinants of the Big Mac index, cross-country panel regression model was used. Five explanatory variables were taken into consideration: labour compensation, gross domestic product per capita, current account balance, general government balance and Index of economic freedom. Using Hausman test fixed effects model was chosen as appropriate. Statistically significant independent variable in regression was current account balance under 5 percent level of significance. Other independent variables were not significant in the model under 10% of significance. It can be concluded there is no clear evidence in favour of accepting the validity of main determinants of Big Mac index but further investigations should be made. Furthermore, majority of panel unit root tests suggest that series of relative PPP is stationary process although Levin, Lin and Chu test point to the opposite. Values of relative purchasing power parity does not bounce back to their equilibrium levels so it can be concluded that relative purchasing power parity does not hold in the long run.

References

1. Alessandria, G., Kaboski, J. P. (2011) "Pricing-to-Market and the Failure of Absolute PPP", *American Economic Journal: Macroeconomics*, 3(1): 91-127.
2. Balassa, B. (1964) "The purchasing power parity doctrine: A reappraisal," *Journal of Political Economics*, pp. 584-96.
3. Bat-Ulzii, T. (2016) „Is the Big Mac Index a reliable index for currency evaluation?“. Article. Available at: <https://www.linkedin.com/pulse/big-mac-index-reliable-currency-evaluation-tengis-bat-ulzii/>. [Accessed 20 November 2017].
4. Cassel, G. (1918) „Abnormal deviations in international exchanges“, *The Economic Journal*, 28 (112), pp. 413-415.
5. Clements, K., Si, J. (2016) „Simplifying The Big Mac Index“, *Journal of International Financial Management & Accounting*, [online] 28(1), pp. 86-99.
6. Feenstra, R. C., Inklaar R., Timmer M. P. (2015) "The Next Generation of the Penn World Table", *American Economic Review*, 105(10), 3150-3182.
7. <https://data.oecd.org/gga/general-government-deficit.htm> [Accessed 20 November 2017].
8. <http://data.worldbank.org/indicator/BN.CAB.XOKA.GD.ZS> [Accessed 20 November 2017].
9. <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD> [Accessed 20 November 2017].
10. <http://www.economist.com/content/big-mac-index> [Accessed 20 November 2017].
11. <http://stats.oecd.org> [Accessed 20 November 2017].
12. Haidar, J. (2011) „Currency Valuation and Purchasing Power Parity“, *World Economics*, [online] 12(3), pp. 1-12.
13. Jošić, H., Barišić, A. (2017) „Apple indices as a new informal measure of Purchasing Power Parity“, *Zbornik EZG*, 15(1), 109-127.
14. O'Brien, T., de Vargas, S. (2016) „The Adjusted Big Mac Methodology: A Clarification“, *Journal of International Financial Management & Accounting*, [online] 28(1), pp. 70-85.
15. Pakko, M. R., Pollard P.S. (2003) "Burgeronomics: A Big Mac™ guide to purchasing power parity", The Federal Reserve Bank of St. Louis, pp.
16. Pakko, M.R., Pollard, P. S. (1996) „For here or to go? Purchasing power parity and the Big Mac“, *Federal Reserve Bank of St. Louis Review*, (Jan), pp.3-22.

Appendix

Table 1: Absolute purchasing power parity valuation, 2000-2016

Country	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Australia	-38.58	-40.35	-35.22	-31.24	-21.63	-18.39	-21.32	-13.53	-5.81	-5.53	2.77	21.62	8.15	1.39	0.40	-18.12	-14.6
Brazil	-34.34	-35.28	-38.21	-45.31	-41.44	-21.77	-10.41	5.77	32.58	12.63	31.44	51.60	14.06	15.98	22.11	-10.59	-5.1
Britain	19.60	12.04	15.88	16.02	16.04	12.43	17.68	17.51	28.03	-3.21	-6.69	-4.26	-3.82	-11.78	2.71	-5.79	-21.8
Canada	-22.76	-15.96	-14.82	-18.56	-19.71	-14.21	1.34	8.01	14.16	-6.13	7.16	23.02	16.06	15.44	9.51	-5.30	-8.6
Chile	-2.34	-17.46	-14.16	-27.85	-24.69	-17.26	-5.04	-12.87	-12.23	-10.64	-10.48	-1.65	-3.92	-13.63	-22.37	-31.76	-29.9
China	-52.36	-52.93	-49.07	-55.88	-56.69	-58.54	-57.80	-57.58	-48.76	-48.76	-47.83	-44.08	-43.39	-42.76	-43.14	-42.84	-44.7
Czech Republic	-44.60	-43.47	-33.52	-27.77	-26.58	-24.87	-13.84	-26.54	27.67	1.95	-8.25	0.18	-22.79	-23.40	-27.94	-40.84	-39.4
Denmark	22.64	15.18	18.61	51.03	53.84	49.53	53.85	49.04	66.72	54.82	31.31	34.87	7.34	7.83	7.31	6.02	-11.9
Euro area	-5.15	-10.96	-4.57	10.00	13.38	17.10	21.51	22.20	49.66	29.33	16.05	21.24	0.39	2.25	3.31	-15.37	-16.6
Hong Kong	-47.83	-45.99	-43.78	-45.60	-46.88	-49.60	-50.07	-54.97	-52.22	-51.93	-49.01	-52.33	-50.85	-51.90	-49.41	-48.28	-50.9
Hungary	-51.59	-48.16	-32.23	-19.28	-13.38	-14.95	-12.45	-2.36	30.10	1.27	-10.70	-0.59	-19.49	-17.39	-21.44	-33.58	-37.5
Indonesia	-27.29	-46.68	-31.86	-32.03	-39.13	-50.01	-49.49	-48.28	-42.77	-42.60	-32.67	-34.96	-41.03	-38.47	-49.36	-52.28	-53.1
Japan	10.50	-6.65	-19.06	-19.43	-20.05	-23.44	-28.06	-32.87	-26.60	-3.16	-1.68	0.45	-5.46	-29.85	-24.00	-37.67	-31.2
Malaysia	-52.61	-53.17	-46.73	-51.06	-54.26	-54.85	-51.12	-53.04	-52.42	-47.35	-41.24	-40.42	-46.12	-49.63	-49.76	-58.04	-60.6
Mexico	-11.51	-7.19	-5.22	-19.40	-28.66	-15.80	-17.24	-21.02	-11.85	-33.07	-32.94	-32.55	-37.53	-37.25	-32.27	-35.01	-52.9
New Zealand	-32.61	-42.62	-35.46	-18.11	-8.54	3.70	-11.45	5.41	4.16	-13.80	-3.84	8.52	-7.46	-5.65	3.12	-18.38	-16.2
Poland	-49.04	-42.36	-41.35	-40.24	-43.87	-35.82	-32.34	-26.47	-3.48	-32.53	-30.46	-24.09	-39.23	-40.01	-37.53	-46.89	-52.0
Russia	-44.78	-52.32	-49.80	-51.35	-50.06	-51.68	-42.79	-40.54	-28.87	-42.77	-37.53	-33.52	-47.11	-42.04	-46.72	-60.68	-59.3
Singapore	-25.01	-28.22	-27.18	-31.59	-33.45	-29.16	-26.84	-23.98	-18.21	-19.28	-17.55	-10.12	-19.21	-19.08	-20.82	-28.19	-20.4
South Africa	-46.64	-53.03	-64.26	-31.91	-35.80	-31.43	-31.79	-34.79	-37.22	-39.28	-34.43	-29.31	-45.56	-50.85	-51.41	-55.28	-58.3
South Korea	7.87	-10.86	-4.53	-0.19	-6.25	-18.75	-15.32	-7.81	-11.95	-27.55	-24.39	-13.82	-25.72	-24.64	-16.48	-21.50	-23.5
Sweden	8.16	-8.09	0.40	32.74	35.94	36.16	46.13	42.49	78.57	38.12	75.82	87.94	32.38	35.12	24.17	7.05	3.7
Switzerland	38.27	43.37	52.42	69.69	68.40	65.04	68.11	52.54	78.13	67.65	65.68	98.35	51.63	47.46	42.36	42.42	30.8
Taiwan	-8.86	-16.23	-19.22	-25.78	-22.57	-21.38	-24.73	-32.88	-30.81	-36.67	-37.43	-36.01	-42.60	-42.26	-45.05	-46.83	-57.3
Thailand	-42.34	-52.41	-48.99	-49.01	-50.14	-51.62	-49.66	-47.23	-47.94	-47.13	-41.96	-42.12	-40.23	-37.55	-35.03	-33.86	-32.5

Source: Authors' from the data available at: <http://www.economist.com/content/big-mac-index>

Table 2: Relative purchasing power parity valuation, 2001-2016, base year 2000

Country	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Australia	-3.22	5.91	12.03	24.83	26.10	22.66	27.71	29.90	48.74	51.73	59.21	45.65	47.85	42.81	33.36	41.70
Brazil	-1.51	-7.90	-25.24	-10.14	40.39	64.70	91.17	123.48	118.40	147.36	173.96	155.19	198.25	225.60	190.68	243.54
Britain	-6.95	-3.43	-3.23	-4.86	-9.30	-5.43	-9.58	-0.87	-19.80	-32.08	-33.20	-32.94	-45.81	-31.64	-39.92	-63.32
Canada	9.52	10.84	5.67	3.19	8.18	23.78	28.62	33.01	15.29	26.67	39.67	37.88	40.84	33.79	26.69	21.09
Chile	-18.12	-15.52	-36.16	-29.13	-18.13	-2.80	-14.13	-15.45	-10.06	-11.73	-5.16	-5.63	-21.80	-34.12	-49.16	-44.93
China	-1.20	6.86	-7.97	-10.49	-15.81	-14.38	-16.59	1.50	1.51	2.75	8.19	8.51	5.85	4.81	5.89	6.42
Czech Republic	2.06	17.35	22.17	20.46	19.09	28.56	7.43	42.23	34.96	25.16	22.01	3.11	-3.71	-13.60	-25.26	-25.63
Denmark	-6.42	-3.43	19.82	19.22	14.78	16.25	8.35	12.39	10.57	-5.90	-11.46	-33.57	-38.66	-44.77	-35.79	-63.62
Euro area	-6.49	0.60	13.35	13.99	16.36	18.75	15.34	30.72	20.39	10.74	7.46	-9.14	-12.44	-16.39	-31.18	-36.05
Hong Kong	3.58	7.90	4.65	2.11	-4.15	-5.39	-18.54	-11.93	-11.33	-3.44	-13.94	-10.23	-14.57	-6.21	-2.09	-12.11
Hungary	7.90	38.70	56.29	65.18	61.44	67.73	76.54	103.70	98.78	89.99	94.83	87.04	90.12	80.82	73.26	62.31
Indonesia	-36.44	-7.55	-6.94	-19.29	-41.36	-40.19	-39.67	-28.46	-26.48	-5.71	-13.82	-24.86	-14.41	-43.16	-48.45	-52.04
Japan	-18.18	-32.73	-32.06	-33.03	-37.55	-44.23	-56.01	-47.80	-20.71	-22.14	-27.04	-37.35	-67.26	-60.96	-81.90	-75.63
Malaysia	-1.20	12.30	3.54	-4.03	-5.76	2.66	-4.56	-5.76	12.76	22.67	19.10	7.79	-3.86	-5.58	-21.75	-29.77
Mexico	4.86	6.96	-9.82	-23.98	-3.43	-4.87	-11.53	2.82	-31.10	-31.46	-32.87	-40.82	-42.16	-27.51	-23.65	-87.24
New Zealand	-18.20	-4.76	19.65	30.81	39.20	26.73	35.77	36.33	22.67	29.03	30.53	14.22	16.44	19.26	7.61	4.95
Poland	12.36	14.12	16.11	9.01	19.30	22.60	25.60	37.80	22.57	27.82	29.92	12.57	7.33	4.80	-4.04	-18.47
Russia	-13.99	-9.94	-13.29	-10.96	-15.25	3.05	5.80	25.61	12.32	24.19	30.54	2.49	23.00	12.04	-19.30	5.83
Singapore	-4.54	-3.14	-9.55	-13.00	-7.10	-4.38	-2.05	1.63	3.50	2.61	4.86	-8.93	-9.78	-16.98	-24.33	-10.34
South Africa	-14.40	-53.63	34.53	23.13	34.16	33.32	32.63	33.55	33.99	44.11	53.43	23.23	18.81	24.72	13.31	20.12
South Korea	-20.78	-13.56	-8.08	-15.10	-29.33	-26.13	-22.45	-27.45	-47.53	-44.11	-33.94	-52.95	-54.17	-46.76	-50.70	-57.10
Sweden	-17.48	-8.52	22.69	23.38	23.09	31.59	24.81	48.67	30.80	69.52	68.05	15.21	15.25	1.21	-5.16	-10.77
Switzerland	3.82	9.93	18.22	15.36	11.48	12.16	-0.32	7.81	4.05	-0.38	0.80	-20.51	-28.40	-39.71	-36.71	-48.63
Taiwan	-8.71	-12.93	-21.69	-17.55	-16.65	-21.40	-35.81	-34.31	-43.50	-46.52	-49.04	-63.94	-66.94	-76.15	-79.35	-106.89
Thailand	-20.93	-13.15	-13.06	-15.63	-19.48	-15.59	-13.80	-17.29	-14.88	-6.48	-12.97	-6.74	-2.15	5.33	15.82	23.55

Source: Authors' calculations