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The impact of U.S. interest rates on economic growth in emerging markets

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Abstract

The focus of this paper is on the relationship between U.S. interest rates and real GDP per capita growth in emerging markets. The analysis of the paper seeks to determine if the relationship is negative and non-linear in nature as postulated by the paper's two hypotheses. Three panel data regressions using the same dependent variable, real GDP per capita growth rate, but different explanatory variables, various types of U.S. interest rates, generate results in support of the postulated negative relationship but rejecting the non-linearity of the negative relationship. This implies that the marginal negative effect on emerging market GDP growth from rising U.S. interest rates will be fairly constant and not depend on the level of the U.S. interest rates themselves. The most statistically significant results were generated by using the Federal Funds Rate as the explanatory variable whereas the 10 Year Maturity Treasury Yield generated the least statistically significant results. The findings of this paper suggest that if U.S. interest rates continue to rise the economic implications for emerging markets will be serious and potentially detrimental. Emerging markets with substantial dollar-denominated debt are especially at risk as rising U.S. interest rates will negatively affect both their exchange rate to the dollar as well as their financial standing and thereby attractiveness among global investors. Provided that the regression analysis was based on data starting in 1980 further research covering a longer time period starting prior to 1980 would be interesting since that would include more years when U.S. interest rates rose and not only fell as was mainly the case in this study.

Keywords: U.S. interest rates, emerging markets, economic growth, central banks

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1. Introduction

Many emerging markets have for several years enjoyed high annual GDP growth rates. Possible explanations as to why are as many as they are diverse (Sneader, 2018). One important aspect that is often cited in the literature is low U.S. interest rates (Ismail, Karunungan and Villamil, 2019). The underlying reasoning for this proposition builds on the fact that U.S. interest rates affect both the risk appetite and market sentiments in the world economy as well as the financial standing of the emerging markets themselves. The many different opinions in the ongoing debate about how rising U.S. interest rates affect emerging markets show that a lot of analysis and research remains to be done on the subject. Adding the unchartered territory of negative interest rates and quantitative easing puts further emphasis on how crucial this topic is in order to understand both the potential future economic growth in emerging economies and political developments in these countries. The focus of this paper is therefore to answer the question if there exists a negative relationship between U.S. interest rates and GDP growth in emerging markets. That is to what degree the economic growth of emerging markets is negatively affected by a hike in the U.S. interest rates and conversely how these countries' economic growth is boosted by the lowering of U.S. interest rates.

In the wake of the 2008 financial crisis we saw an expansionary monetary policy for almost a decade when the United States and most other countries sought to mitigate the economic problems through expansionary monetary policy. This changed in 2015 when the Federal Reserve instead started to raise the interest rate. Ever since this turn of events there has been an ongoing debate as to how detrimental the increasingly contractionary U.S. monetary policy will be not only for financial markets but also for the global economy as a whole (Kihara, 2019). The end of "easy money" through quantitative easing as well as a pickup in interest rates has the financial world discussing and reassessing the future trajectory of global economic growth in general and emerging markets in particular (Domm, 2018).

Since the Federal Reserve started to raise interest rates in 2015 we have increasingly been able to observe the multifaceted impact of rising U.S. interest rates on the rest of the world such as dampening the rally in stock markets and pressuring the fiscal balances of emerging markets (Ismail, Karunungan and Villamil, 2019; Rushe, 2018). The preceding period of sustained low interest rates in the aftermath of the 2008 financial crisis

on the other hand saw increased lending to emerging markets which in turn stimulated investments and economic growth in these countries (Valladares, 2019; Avdjiev, Binder & Sousa, 2017). A worry held by many economists is that the extensive borrowing to emerging markets during the last couple of years will come back and haunt them as the U.S. interest rates are now on an upwards trajectory (Bräuning & Ivashina, 2018). This brings us to the second topic of this paper, if the marginal effect of U.S. interest rates on GDP growth in emerging markets is linear or non-linear in nature. That is, if the impact of U.S. interest rates is constant or if it depends on the level of the U.S. interest rates themselves. Pursuing this comparison will shed light if and how different levels of U.S. interest rates affect emerging market GDP growth differently and thus provide insight as to how countries across the globe will be affected by ever higher U.S. interest rates.

The structure of this paper follows a logical order starting with a description of the theory of this paper, followed by the formulation of the two hypotheses that are going to be tested. Subsequently we turn to the actual econometric analysis, beginning with the methods and data used in the regression models. Thereafter the results of the regression analyses are presented with an ensuing discussion what the results are telling us about the relationship between U.S. interest rates and the economic growth in emerging markets. Concluding this paper is a summary what the analysis has shown us and what research remains to be done in order to further test the two hypotheses.

As you will see the findings of this paper indicate that there de facto exists a negative relationship between U.S. interest rates and GDP per capita growth in emerging markets. Based on the results this negative relationship is linear in nature. Thus the second hypothesis of this paper is rejected, that the negative relationship between U.S. interest rates and emerging market growth is non-linear.

Before starting the analytical part of this paper I also want to state that in order to be coherent and prevent any misconceptions this paper will continuously refer to the economies of emerging markets as “emerging markets”.

2. Theories about growth and international interest rates

The impact of U.S. interest rates on emerging markets has been covered extensively in numerous studies and publications over the last couple of decades, some of which I will refer to in this paper such as (Kamin & Von Kleist, 1999) and (Arora & Cerisola, 2001) among

others. Although there are disagreements as to how significant the impact of American monetary policy is on investments in emerging markets there is also a certain degree of unanimity with regards to specific findings and propositions. This paper contributes to the debate by presenting results based on the latest data supporting the postulated negative relationship between U.S. interest rates and economic growth in emerging markets. This is an important finding provided the serious societal implications that the negative relationship potentially will have in emerging markets as U.S. interest rates get ever higher. Breaking down and analysing the results in further detail I will moreover offer insight into the functioning of this negative relationship.

A well-established point of view is that as the mood of global investors deteriorate with higher U.S. interest rates they tend to turn to generally safer investments such as in the United States over more risky ones like in emerging markets. This is because the perceived prospects of high returns on emerging market investments have worsened. The contrary is the case when market sentiments are brighter and U.S. interest rate usually lower (Calvo, Leiderman & Reinhart, 1993, p. 109-10). Furthermore many emerging markets have dollar denominated debt and this makes them vulnerable to fluctuations in the U.S. dollar exchange rate which in turn is directly affected by U.S. interest rates (Gorman, 2019; Kamin & Von Kleist, 1999, p. 20-21). Epitomizing this is the extreme volatility in emerging market currencies such as the Turkish lira and the Argentine peso where among other factors the fear of ballooning dollar debt has had investor scrambling for the door, sending the two currencies into a tailspin during a couple of months in 2018 (Villamil and Stratton, 2018). Although the two currencies have recuperated some of their losses vis-à-vis the dollar they nevertheless remain in focus among weary investors fearing a "contagion" to other emerging markets around the world as the U.S. interest rates keep on rising (Inman, 2018). Altogether there is a variety of different causal explanations as to why there exists a negative relationship between U.S. interest rates and GDP growth in emerging markets. As briefly described above and later further explained the reasons are both structural for the economy as a whole and individual for the particular emerging market.

Adding yet another dimension to this discussion is the concept of a "goldilocks economy". A concept championed by some economist who argue that in the initial phases of monetary tightening, when the levels of interest rates are still low, there is a period when interest rates are just high enough to contain inflation but low enough to sustain economic

growth (Maliszewski & Zhang, 2015, p. 3). The theory nevertheless also has its detractors who are less convinced that the combination of low inflationary economic growth and low interest rates will prevail (Ossinger, 2019). This debate about how the impact on emerging market GDP growth from rising U.S. interest rates depends on the actual level of the interest rates gives rise to the second hypothesis postulated in this paper, that the marginal negative effect of rising U.S. interest rates on emerging markets is non-linear. In this case the non-linearity would imply that the marginal negative effect grows in magnitude as the level of the U.S. interest rates increases.

2.1 First hypothesis: That there is a negative relationship between U.S. interest rates and GDP growth in emerging markets

In the world economy there is a plethora of investment opportunities and alternatives where risk-tolerant investors seeking a higher rate of return may put their money, more so today in our globalized world than ever before. One such alternative investment consists of the numerous emerging markets where investment opportunities are plentiful but at the same time the risks deemed to be higher. This also means that emerging markets have a greater chance of luring foreign investors to finance their booming economies. Nonetheless, in order to attract foreign investors the emerging markets have to compete not only amongst themselves but indeed also with investment opportunities presented by richer countries. Furthermore, the higher the perceived risk in an emerging market the higher is also the demanded return among investors to invest in that particular market. It is from this international competition for investments that we derive the negative relationship between U.S. interest rates and economic growth in emerging markets. This leads us to our first hypothesis;

H1: there is a negative relationship between U.S. interest rates and GDP growth in emerging markets

Theoretically there are various explanations as to why and how an adjustment in either direction of U.S. interest rates will affect conversely the amount of investments in emerging markets. As presented by (Kamin & Von Kleist 1999, p. 20) one of the theories explaining this negative relationship is the fact that more risky investments, in this case

investments in emerging markets, need to have a much higher rate of return than that of less risky investments, i.e. investments in the United States, in order to attract investors. Referred to by (Kamin & Von Kleist) as the "'mathematical' effect" this is because if one investment has a higher risk of defaulting than another less risky investment then this has to be compensated for with a higher rate of return for the more risky investment in order for the expected rate of return to be the same for both investments (Investopedia). Accordingly a hike in the U.S. interest rates, implying a higher rate of return from the less risky investment, means that the rate of return has to increase also for the more risky investment, in this case emerging markets, in order to stay attractive to investors. This means that there is a positive relationship between the U.S. interest rates and the required rate of return on investments in emerging markets, meaning that when the U.S. interest rates increase then the return from emerging market investments also has to increase. This is succinctly portrayed by (Kamin & Von Kleist) in the following equation where i represents the rate of return on the risky investment (investing in emerging markets), r the rate of return on the safe investment (investing in the United States), p the probability of earning money and 0 the risk of earning no money:

$$(1 + r) = p(1 + i) + (1 - p)0 \qquad (1)$$

which implies the following equation for the spread between the return from the risky asset and the return from the safe asset:

$$i - r = \frac{(1+r)(1-p)}{p} \qquad (2)$$

This formula clearly shows that if r, the rate of return on the less risky asset, increases then i, the rate of return on the more risky asset, has to increase at an even larger extent in order for the equilibrium to hold, that is for the two investments to stay equally attractive to investors. Naturally not all risky investments, i.e. investments in emerging markets, will be able to increase their rate of return. For this reason at times of rising U.S. interest rates emerging markets will lose their appeal to global investors vis-à-vis investing in products benefiting from the rising U.S. interest rates. As put by (Kamin & Von Kleist) this means that

in addition to other factors a hike in the U.S. interest rates would affect negatively economic growth in emerging markets "for 'mathematical' reasons alone". By "mathematical" they refer to the fact that all things equal a higher U.S. interest rate will automatically affect emerging market growth negatively by requiring a higher rate of return on the more risky investments in these countries, in order for them to stay equally attractive to investors.

Another aspect explored by (Kamin & Von Kleist, p. 20-21) is the fact that higher interest rates in an industrial country, i.e. the U.S., means that the borrowing costs held by its debtor countries also will increase. Provided that many emerging markets have dollar denominated debt this means that their borrowing costs will rise together with the U.S. interest rates (Gorman, 2019). This subsequently worsens their creditworthiness, making investing in them more risky, meaning that the required rate of return on investments in emerging markets also has to increase in order for these investments to stay attractive to investors. This theory is supported by (Iacoviello & Navarro, 2018) and their study stretching from the monetary tightening of the late 1970s to the tightening of the early 2000s. They conclude that contractionary U.S. monetary policy over time has had a particularly adverse impact on economic growth especially in heavily indebted emerging markets with high inflation.

A third conceivably causal relationship between U.S. interest rates and investments in emerging markets is what (Kamin & Von Kleist, p. 21) refer to as the "'appetite for risk' argument". Postulating a positive relationship between interest rates in industrial countries and the spread in returns between risky investments and safe investments this theory suggests that lower U.S. interest rates would make investors more willing to put their money in more risky investments, in this case emerging markets. It is from this search for diversification that the term "'appetite for risk'" originates. Put differently, as the spread between safe and risky investments follows the U.S. interest rates downwards investors would start to look elsewhere for alternative investments to diversify their portfolios, one of which is investing in emerging markets. Investments pouring into these countries would in turn trigger economic growth, signalling a negative relationship between U.S. interest rates and GDP growth in emerging markets. This is supported by (Calvo, Leiderman, & Reinhart, p. 109-10) and (Arora & Cerisola, p. 474-75) who both use the easing and subsequent tightening of American monetary policy in the 1990s to showcase how U.S. interest rates affect the risk appetite in financial markets. (Calvo, Leiderman, &

Reinhart) point out how among other factors “falling interest rates” in the United States in the early 1990s “encouraged investors to shift resources to Latin America to take advantage of renewed investment opportunities and the region’s increased solvency.” This claim highlights the manifold impact of U.S. interest rates on emerging markets, incorporating both the direct effect on the cost of borrowing for the debtor countries as well as the indirect effect from these countries luring away investors from American equities suffering from the low interest environment. (Arora & Cerisola) elaborate how the reversal in U.S. monetary policy had an adverse effect on emerging markets when in 1994 “a tightening of U.S. monetary policy was reflected in a substantial widening of spreads” between the “yields on sovereign bonds of developing countries and U.S. Treasury securities of comparable maturities”. The relatively higher yields on emerging market bonds implied a lower price on emerging market bonds, indicating that fewer investors wanted to invest in these countries’ bonds (Asgharian & Nordén, 2007, p. 83). This provides yet another historical example supporting the theory that risk appetite is an important component explaining the negative relationship between U.S. interest rates and emerging market GDP growth.

2.2 Second hypothesis: that the marginal negative effect of U.S. interest rates on emerging market GDP growth increases as the level of U.S. interest rates themselves increases

The second hypothesis of this paper builds on the first hypothesis in the sense that it examines if the postulated negative effect of U.S. interest rates on emerging markets’ economies is constant or if it changes depending on the actual level of the U.S. interest rates themselves. Provided that the first hypothesis is correct, that there exists a negative relationship between U.S. interest rates and emerging market GDP growth, a non-linear relationship would imply that the negative effect of U.S. interest rates increases at an exponential rate as the interest rates get higher. That is, the magnitude of the negative effect on emerging markets would grow as the U.S. interest rate reaches ever higher levels. If on the other hand only the first hypothesis is correct, then the negative effect of U.S. interest rates will be linear and the marginal effect won’t change depending on the levels of the U.S. interest rates. It is based on this that we formulate our second hypothesis;

H2: the marginal negative effect of U.S. interest rates on emerging market GDP growth increases as the level of U.S. interest rates themselves increases

The rationale behind a non-linear negative effect of U.S. interest rates on emerging markets originates in the fact that many emerging markets either have dollar denominated debt or their attractiveness among global investors are directly or indirectly affected by U.S. interest rates. This is eloquently portrayed by (Arora & Cerisola 2001, p. 476-77) and their differentiation of equation 2, $i - r = \frac{(1+r)(1-p)}{p}$, with respect to r. By differentiating equation 2 with respect to r they demonstrate the multifaceted relationship between the U.S. interest rates, representing the non-risky investment r, and the rate of return on investment in emerging markets, representing the risky investment i:

$$\frac{d(i-r)}{dr} = \left(\frac{1-p}{p}\right) - \left((1+r)\frac{p'}{p^2}\right) \qquad (3)$$

This equation clearly shows that if the U.S. interest rates increase then the emerging markets' returns on investments have to increase even further in order to stay equally attractive to investors. The first term, $\left(\frac{1-p}{p}\right)$, represents the probability of default and the second term, $\left((1+r)\frac{p'}{p^2}\right)$, represents how that risk in itself becomes more likely as the U.S. interest rates and thereby the borrowing costs go up. This indicates that the risk of emerging markets defaulting on their loans increases as the levels of the U.S. interest rates increases, which in turn implies a non-linear negative marginal effect on emerging markets from rising U.S. interest rates. This theory is supported by (Iacoviello & Navarro, p. 6) and their findings that the more financially "vulnerable" the emerging market the more that country's GDP fell during times of higher U.S. interest rates. According to their study factors determining the vulnerability of an emerging economy were identified as "a country's current account deficit, foreign reserves, inflation, and external debt."

The possible non-linear negative relationship between U.S. interest rates and emerging market GDP growth has also been floated in numerous papers and articles written on the topic of the "goldilocks economy". This is a condition observed in the U.S. during the

1990s when high growth figures coexist with low inflation, allowing for interest rates to remain low as well and by so doing fuelling continuous economic growth (Gordon & Stock, 1998 p. 297-98). A non-linear negative relationship between U.S. interest rates and emerging market economic growth would nevertheless mean that as inflation picks up and thus the U.S. interest rates rise the negative marginal effect would increase and thereby end the "goldilocks economy" (Ossinger, 2019). Some argue that the world economy is in a similar situation today with booming economic growth across the globe and inflation kept at bay in most countries without quickly rising interest rates (Pereira da Silva & Schanz, 2018, p. 1-2). Although the Federal Reserve has initiated the process of monetary tightening the rate at which they are hiking the interest rate is still very modest and economic growth in the U.S. is still high. The same scenario is to be observed in most emerging markets where countries, apart from some where inflation is running rampant, currently reap the benefits from being part of this global "goldilocks moment" (Wigglesworth, 2019). Just like the U.S. these emerging markets enjoy impressive growth figures, fuelled by among other things investors eager to put their money at work. It remains to be seen if this positive growth trend continues as the U.S. interest rates keep on rising but a non-linear negative relationship suggests that would not be the case.

We have now covered numerous authors and studies on the subject of U.S. monetary policy's impact on emerging market, exploring the theories underlying the model used to examine the two questions of this paper: *is there a negative relationship between the U.S. interest rate and GDP growth in emerging economies; and if there is one, is the relationship linear with a constant negative marginal effect or non-linear with an increasing negative marginal effect*? Now will follow an examination of the data analysis upon which I have tested my two hypotheses but previous to that I will introduce the model by which I will analyse the data.

3. Empirical analysis

In order to test the two hypotheses of this paper in order to answer the question if there indeed is a negative relationship between U.S. interest rates and GDP growth in emerging markets I have pursued an econometric analysis incorporating many different factors. The main focus of the analysis has been to determine to what extent the U.S. Federal Funds Rate and the 2 year yield as well as the 10 year yield affect GDP growth in emerging markets and

whether the effect is non-linear. The scope of the study has been broad, including emerging markets from different continents and regions, in order to have as comprehensive a study as possible and moreover highlight if there are differences in their relationship to U.S. monetary policy.

3.1 Regression model

In this econometric analysis I use *real GDP per Capita growth at chained PPPs* as the dependent variable and the following interest related factors as explanatory variables: *The Federal Funds Rate of the U.S. Federal Reserve*; *2 year U.S. Treasury yield*; *10 year U.S. Treasury yield*. The regression model used in this paper to test the first hypothesis, the negative relationship between emerging market GDP growth and U.S. interest rate is the following linear regression model:

$$\Delta y_{i,t} = \alpha + \beta f_{i,t-1} + \delta x_{i,t-1} + c_i + u_t + \varepsilon_{i,t} \qquad (4)$$

Where $\Delta y_{i,t}$ represents the dependent variable of this paper's analysis, i.e. real GDP per capita growth rate of the emerging market in land i during period t; α is a constant; $f_{i,t-1}$ represents U.S. interest rates in this econometric analysis for country i during period $t-1$; $x_{i,t-1}$ represents the control variables used in this analysis controlling for both domestic and international factors in country i during period $t-1$; c_i and u_t are country specific and time specific effects; and $\varepsilon_{i,t}$ is the error term used in this analysis. In the above regression model parameter β represents the marginal effect of U.S. interest rates. If the hypothesis of this paper is correct, that there indeed is a negative correlation between U.S. interest rates and emerging market GDP growth, then we should expect β to be negative and large enough to be statistically significant.

The second hypothesis postulating a non-linear negative marginal effect of U.S. interest rates on emerging market GDP growth as the level of U.S. interest rates rises is tested by the following regression model:

$$\Delta y_{i,t} = \alpha + \beta f_{i,t-1} + \gamma \left(f_{i,t-1}\right)^2 + \delta x_{i,t-1} + c_i + u_t + \varepsilon_{i,t} \qquad (5)$$

Where we have added the non-linear term $\left(f_{i,t-1}\right)^2$ to the first regression model making it a non-linear model. In order to determine the marginal effect of higher U.S. interest rates we have to differentiate the model with respect to *f* which gives us the following:

$$\frac{d\Delta y_{i,t}}{df_{i,t-1}} = \beta + 2\gamma f_{i,t-1} \qquad (6)$$

After differentiating it is clear that the marginal effect of U.S. interest rates on emerging market growth is no longer represented by only β but by $\beta + 2\gamma f_{i,t-1}$ as a whole. This allows for an analysis as to what extent the level itself of the U.S. interest rate has an impact on growth in emerging markets. If indeed rising U.S. interest rates do increase the negative marginal effect of U.S. interest rates on emerging markets then we expect β to be fairly small and γ to be negative and fairly strong.

The control variables are many and different in nature. Two of the control variables are the local interest rate in the emerging markets and their exchange rate to the U.S. dollar. Controlling for exchange rate and local interest rate is important in order to take into account the domestic monetary factors affecting economic growth in emerging markets and separate them from the impact of U.S. interest rates. The productivity of the emerging markets examined is just as important for economic growth and thus one needs control variables accounting for this as well as. The three productivity oriented control variables are employment rate which is measured by the share of population employed in these countries, the capital stock and its share of real GDP per capita at current PPPs. These three variables control for the productivity in the countries through their ability to create jobs and generate investments in capital. Exports from the emerging markets is yet another crucial determinant of economic growth and thus it has to be incorporated into the regression model. This is done by introducing the following control variables: emerging market exports of goods and services; the share of real GDP per capita at current PPPs that is constituted by merchandise exports. The last control variable is the share that government consumption contributes to real GDP per capita at current PPPs and it's important because it indicates to what extent economic growth in emerging markets is spurred by activity in the public and private sectors respectively.

With data from different countries over an extended period of time the regression analysis of this paper has been run on a data set consisting of panel data, as opposed to cross sectional data which contains data from different units but at only one specific point in time (Deaton, 1985, p. 109-110). Analyzing panel data requires taking into account both possible individual and time specific effects in order to get OLS measurements that are unbiased, consistent and efficient. If not controlling for individual and time specific effects, there is a risk that omitted variables will correlate with included explanatory variables which in turn results in the explanatory variables becoming endogenous because the effects of the omitted variables are going to be included in the error term. For example the global economic cycle and its impact on our dependent variable, economic growth rate, our explanatory variables, U.S. interest rates, as well as our control variables such as employment rate and capital formation represents a time specific effect affecting all the examined countries equally. In terms of individual specific effects it is fairly easy to contemplate that each country included in this analysis has its own unique aspects affecting at least the dependent variable and the control variables. This paper mitigates the problem of individual and time specific effects by using the error component model which allows controlling for both types of effects when analyzing the panel data.

However, it is equally important to determine if the explanatory variable is exogenous with respect to the individual specific effects and the time specific effects. If the explanatory variable is exogenous then the effects in question are said to be random. If on the other hand the explanatory variable is correlated to the individual or time specific effects then the effects are considered to be fixed effects. Since our explanatory variable, the U.S. interest rate, is the same for each and every country we may not us fixed time specific effects because then we will get multicollinearity. Thus we will use both no effects and random effects for the time specific effects to assess which one is the most correct. For the individual specific effects we will at all times use fixed effects.

Having established that the individual specific effects are fixed on an aggregated level for all our explanatory variables and the time specific effects are either random or non-existent there is yet another potential measurement hazard that have to be mitigated before we may proceed with our econometric analysis and that is possible endogeneity between the dependent and the explanatory variables. If this is the case then

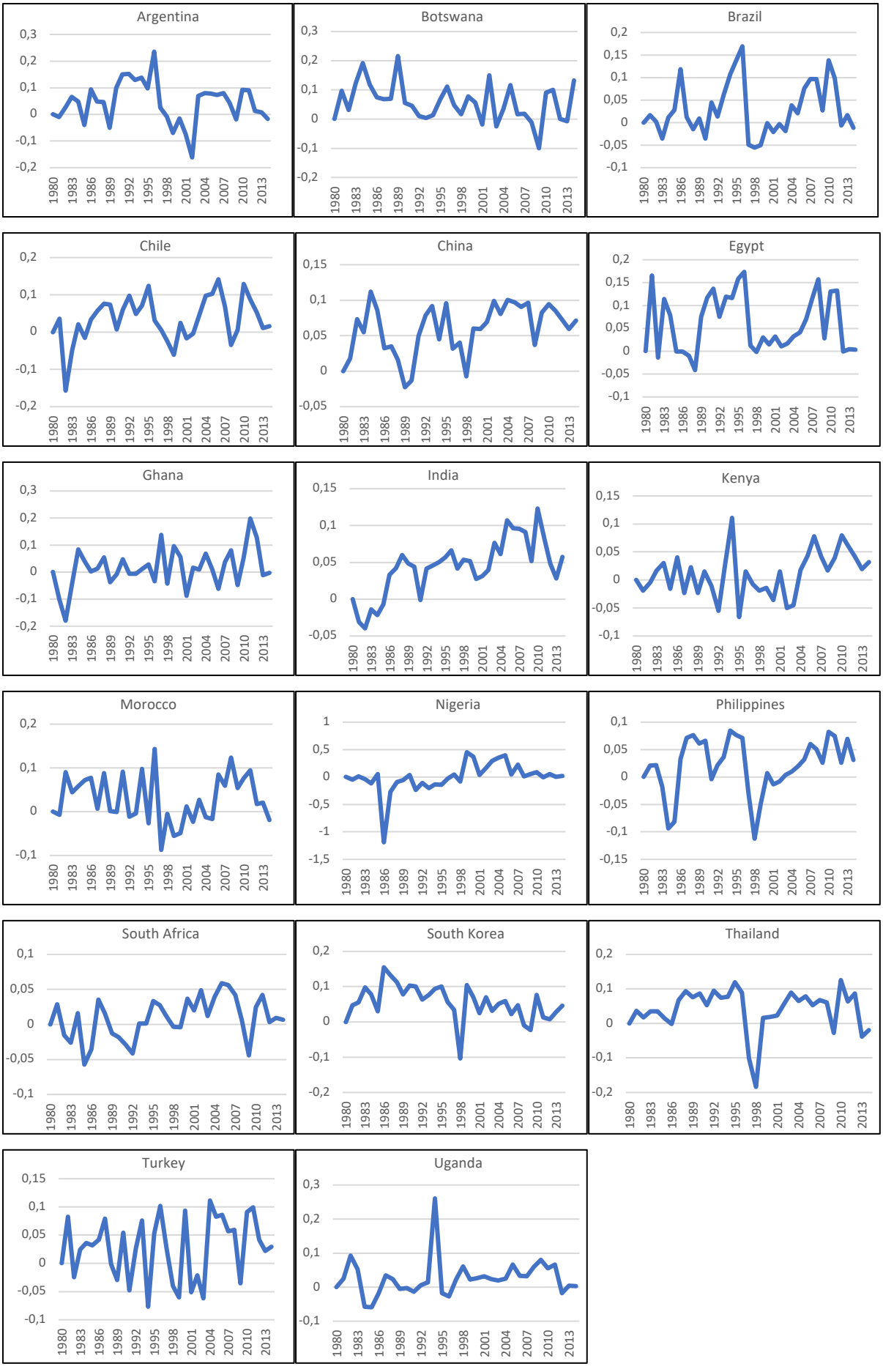
the explanatory variable becomes endogenous. This problem is solved in this paper by lagging the explanatory variables one time period.

3.2 Data

I will pursue a data analysis to examine if there indeed is a negative correlation between emerging market GDP growth and U.S. interest rates. The data I have chosen to include in this study originates from various sources. The dependent variable, *real GDP growth*, is constructed by Output-side real GDP at chained Purchasing Power Parities and the data is derived from the Penn World Tables. Constituting the explaining variables the data for the Effective Federal Funds Rate and the 2-Year as well as the 10-Year Treasury Constant Maturity Rate all originates from the Federal Reserve Bank of St. Louis. With regards to the data pertaining to my control variables it is sourced from the Penn World Tables, the World Bank and the International Monetary Fund.

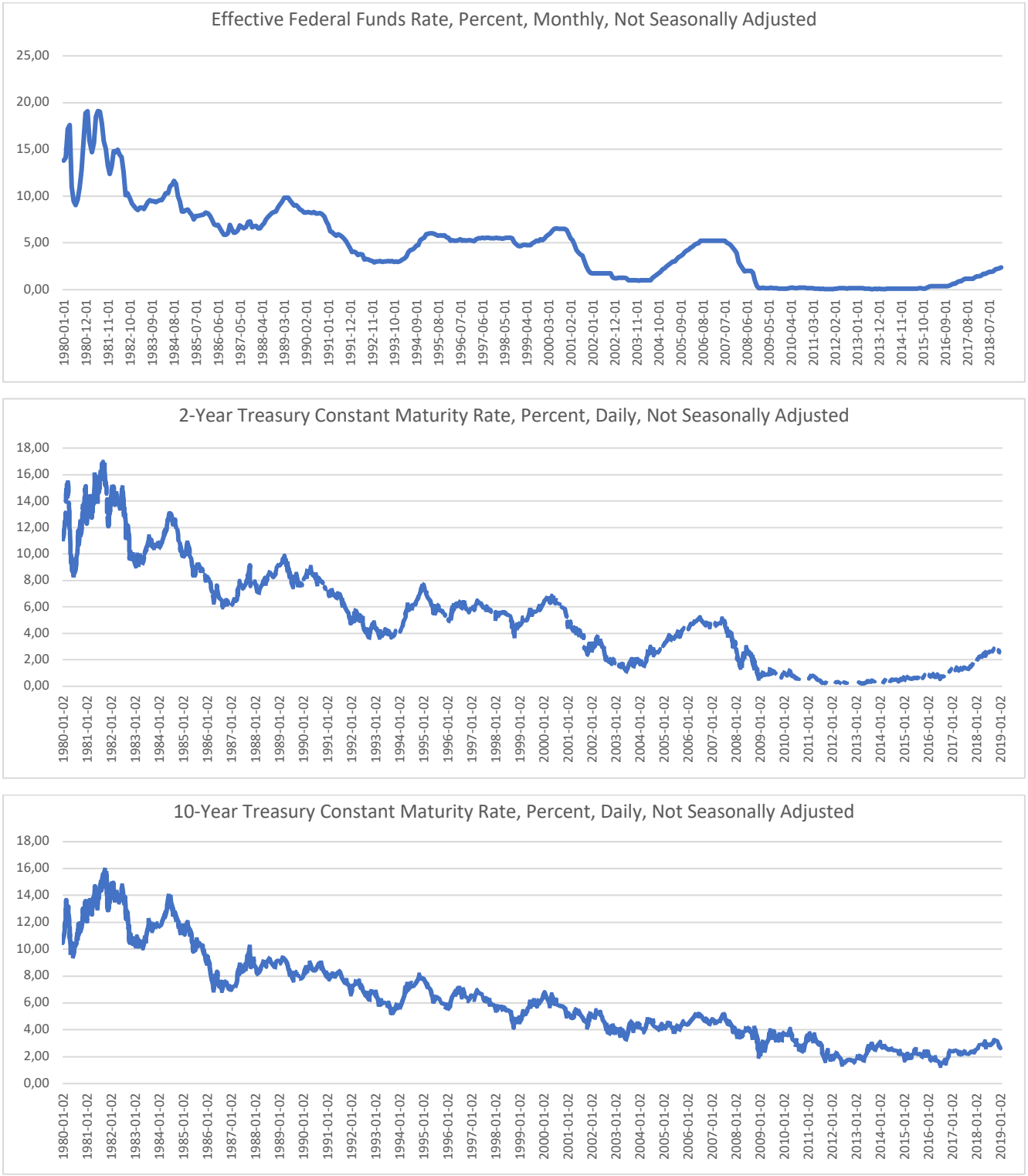
In total this paper has included data from the 20 countries shown in Diagram 1 and the period for which the data has been collected is 1980-2014. The length of the time series is the same for all countries in this study and this means that the panel data is balanced. Although all countries in this study except for Nigeria has experienced positive GDP growth per capita during the period covered Diagram 1 shows that the rate of growth has varied greatly between the countries. Countries like India, China and Vietnam for example have experienced perpetual, nearly exponential growth, judging by their charts. Many of the African countries such as Uganda, Kenya and Morocco have indeed also seen their economies continuously growth but at a more subdued rate.

Diagram 1: Percentage change in output-side real GDP at chained PPPs (in mil. 2011US$) per capita in emerging markets



As showcased by Diagram 2 the U.S. interest rates have during the same period trended downwards from levels around 15 % in the early 80's to near zero ever since the 2008 financial crisis although one may observe a subtle trend upwards in recent years.

Diagram 2: U.S. interest rates 1980 – 2019 (United States. Federal Reserve bank of St. Louis, 2019)



3.3 Results

3.3.1 The Federal Funds Rate of the U.S. Federal Reserve

Table 1 shows the results of the regression analysis of both the linear and non-linear relationship between the Federal Funds Rate and real GDP per capita growth in emerging markets. All the regressions in this paper include fixed individual specific effects whereas time specific effects are only included in the regressions represented by columns 2, 4, 6 and 8. The time specific effects are random and not fixed in order to prevent multicollinearity.

By judging from the results an increase in the explanatory variable, Federal Funds Rate, has a negative impact on emerging market GDP per capita growth, regardless if we are including control variables and time specific effects or not. Analyzing the regression results in further detail it is clear from comparing columns 2 and 3 that the marginal effect decreases when introducing control variables. Simultaneously it increases the P-value of the estimate for the explanatory variable from a level of significance of 0,5 % to 1,1 %. The R^2 also increases when adding the control variables, indicating a more comprehensive explanatory power of the regression model. The introduction of random time specific effects further increases the P-value of the explanatory variable to a 6,1 % significance level but not the R^2 which decreases slightly and it barely alters the marginal effect of our explanatory variable. The impact on the control variables from including time specific effects differs between each variable, both in terms of the P-value and the marginal effect.
Furthermore, the results in columns 5-8 show that including a non-linear explanatory variable in the regression model increases the marginal effect of the linear explanatory variable whereas the marginal effect of the non-linear explanatory variable is negligible. Moreover the high P-values of the non-linear explanatory variable indicate that the results are statistically non-significant and therefore we may conclude that there is no non-linear marginal effect. When including the non-linear explanatory variable the results for the linear explanatory variable are only statistically significant in columns 5 and 6, at a rate of 1,1 % and 5,9 % respectively, when no control variables are included in the regression model.

Altogether the results provide strong evidence to support the first hypothesis that there is a negative relationship between U.S. interest rates and GDP growth in emerging markets. On the contrary the lack of a non-linear marginal effect means that there is not sufficient evidence to support the second hypothesis that the negative marginal effect of U.S. interest rates on emerging market economic growth increases as the level of the U.S.

interest rates themselves increases. Based on the statistically significant results for the linear explanatory variable in columns 1-6 a 1 % increase in the Federal Funds Rate will cause an overall decrease in the emerging market GDP per capita growth rate at an extent ranging from 0.239 % (column 4) to 0.609 % (columns 5 and 6). This decrease in emerging market growth will be linear and thereby constant in nature as the Federal Funds Rate increases. The fact that the Federal Funds Rate exercise such an influence on emerging market growth is of importance when trying to analyze the future economic trajectory of developing countries. Exemplifying this was when the chairman of the Federal Reserve at a press conference stated that within the scope of their "domestic mandate" he and the other board members acknowledged that "when we're raising rates that puts upward pressure on interest rates around the world and can affect countries, particularly countries that have significant external dollar borrowing" (Powell, 2018).

Table 1: Relationship between the Federal Funds Rate and real GDP per capita growth in emerging markets

Dependent variable: GDP per capita growth rate	(1) no time specific effects	(2) random time specific effects	(3) no time specific effects	(4) random time specific effects	(5) no time specific effects	(6) random time specific effects	(7) no time specific effects	(8) random time specific effects
1. Federal Funds Rate (Linear)	-0.325 (P 0.000) (SE 0.086)	-0.325 (P 0.005) (SE 0.117)	-0.243 (P 0.011) (SE 0.096)	-0.239 (P 0.061) (SE 0.127)	-0.609 (P 0.011) (SE 0.238)	-0.609 (P 0.059) (SE 0.322)	-0.292 (P 0.232) (SE 0.244)	-0.292 (P 0.381) (SE 0.333)
2. Federal Funds Rate^2 (Non-lin)					0.021 (P 0.202) (SE 0.016)	0.021 (P 0.345) (SE 0.022)	0.004 (P 0.827) (SE 0.017)	0.004 (P 0.862) (SE 0.023)
3. Local interest rate in em. market			0.000 (P 0.196) (SE 0.000)	0.000 (P 0.175) (SE 0.000)			0.000 (P 0.198) (SE 0.000)	0.000 (P 0.175) (SE 0.000)
4. Employment rate			-0.184 (P 0.483) (SE 0.262)	-0.154 (P 0.555) (SE 0.260)			-0.184 (P 0.484) (SE 0.262)	-0.152 (P 0.559) (SE 0.260)
5. Capital stock			0.317 (P 0.000) (SE 0.044)	0.316 (P 0.000) (SE 0.044)			0.317 (P 0.000) (SE 0.044)	0.316 (P 0.000) (SE 0.044)
6. Exchange rate, loc. currency/USD			0.006 (P 0.550) (SE 0.010)	0.006 (P 0.566) (SE 0.010)			0.006 (P 0.537) (SE 0.010)	0.006 (P 0.559) (SE 0.010)
7. Share of gov. consumption			0.330 (P 0.070) (SE 0.182)	0.358 (P 0.050) (SE 0.182)			0.324 (P 0.079) (SE 0.184)	0.355 (P 0.053) (SE 0.183)
8. Share of gross capital formation			-0.041 (P 0.763) (SE 0.135)	-0.017 (P 0.900) (SE 0.137)			-0.040 (P 0.766) (SE 0.135)	-0.016 (P 0.909) (SE 0.137)
9. Share of merch. exports			0.112 (P 0.285) (SE 0.105)	0.128 (P 0.229) (SE 0.106)			0.113 (P 0.285) (SE 0.105)	0.129 (P 0.226) (SE 0.106)
10. Exports from emerging market			0.048 (P 0.107) (SE 0.030)	0.060 (P 0.049) (SE 0.030)			0.049 (P 0.104) (SE 0.030)	0.060 (P 0.047) (SE 0.030)
Observations	680	680	561	561	680	680	561	561
R^2	0.063	0.056	0.197	0.193	0.065	0.057	0.197	0.193

3.3.2 Two year U.S. Treasury yield

Table 2 shows the results of the regression analysis of the linear and non-linear relationship between the two year maturity U.S. Treasury yield and real GDP per capita growth in emerging markets. Just like in the case with the Federal Funds Rate all the regressions in this analysis include fixed individual specific effects whereas random time specific effects are only included in the regressions represented by column 2, 4, 6 and 8.

Observing the results one conclusion that may be drawn is that there indeed exists a negative relationship between the two year U.S. Treasury yield and GPD per capita growth in emerging markets. This is clearly shown by the negative marginal effect of the linear explanatory variable in each and every column. Introducing control variables into the regression model generates similar results to those of table 1 with higher P-values and lower marginal effects for both the linear and non-linear explanatory variable. Similarly the explanatory power of R^2 for the regression results also increases significantly when control variables are included. Adding random time specific effects further increases the P-values of the linear and non-linear explanatory variable while slightly reducing the marginal effect of the same as well as the R^2 for the entire regression model.

Compared to table 1 the P-values of both the linear and non-linear explanatory variable are relatively higher. This indicates that the results are of less statistical significance, illustrated by the fact that the result of the linear explanatory variable in column 6 is non-significant as opposed to its equivalent in table 1 which is statistically significant. The results for the linear explanatory variable are thus statistically significant in columns 1-5, ranging from a level of significance below 1 % to 8,1 %. Turning to the non-linear explanatory variable all of the results are once again statistically non-significant. Hence we may draw the same conclusion as in the case of the Federal Funds Rate that the negative relationship between the two year maturity U.S. Treasury yield and emerging market GDP growth is linear and not non-linear in nature. This implies a constant negative marginal effect on emerging market growth independent of the level of the yield itself.

With regards to our two hypotheses the results support the first hypothesis of a negative relationship between U.S. interest rates and GDP growth in emerging markets but they reject the second hypothesis that the marginal effect of U.S. interest rates on emerging market GDP growth increases as the level of the U.S. interest rates rises.

The statistically significant results for the linear explanatory variable in columns 1-5 show us that when the two year U.S. Treasury yield increases by 1 %, this will generate a decrease in GDP growth rate per capita on an aggregated level for the emerging markets included in this analysis, ranging from -0.232 % (column 4) to -0.508 % (column 5). This is less than the effect of the Federal Funds Rate but still substantial enough to take into account when analyzing the growth prospects of emerging markets.

Table 2: Relationship between the 2 year U.S. Treasury yield and real GDP per capita growth in emerging markets

Dependent variable: GDP per capita growth rate	(1) no time specific effects	(2) random time specific effects	(3) no time specific effects	(4) random time specific effects	(5) no time specific effects	(6) random time specific effects	(7) no time specific effects	(8) random time specific effects
1. 2 year US treas. Yield (Linear)	-0.354 (P 0.000) (SE. 0.092)	-0.354 (P 0.004) (SE 0.124)	-0.237 (P 0.019) (SE 0.101)	-0.232 (P 0.086) (SE 0.135)	-0.508 (P 0.081) (SE 0.291)	-0.508 (P 0.200) (SE 0.396)	-0.187 (P 0.529) (SE 0.296)	-0.194 (P 0.637) (SE 0.410)
2. 2 year US Treasury yield^2 (Non-linear)					0.012 (P 0.579) (SE 0.021)	-0.012 (P 0.683) (SE 0.029)	-0.004 (P 0.856) (SE 0.021)	-0.003 (P 0.921) (SE 0.030)
3. Local interest rate in em. market			0.000 (P 0.206) (SE 0.000)	0.000 (P 0.179) (SE 0.000)			0.000 (P 0.205) (SE 0.000)	0.000 (P 0.178) (SE 0.000)
4. Employment rate			-0.179 (P 0.495) (SE 0.262)	-0.150 (P 0.564) (SE 0.260)			-0.179 (P 0.496) (SE 0.262)	-0.149 (P 0.568) (SE 0.261)
5. Capital stock			0.317 (P 0.000) (SE 0.044)	0.316 (P 0.000) (SE 0.044)			0.317 (P 0.000) (SE 0.044)	0.316 (P 0.000) (SE 0.044)
6. Exchange rate, loc. currency/USD			0.006 (P 0.545) (SE 0.010)	0.006 (P 0.565) (SE 0.010)			0.006 (P 0.559) (SE 0.010)	0.006 (P 0.572) (SE 0.010)
7. Share of gov. consumption			0.327 (P 0.073) (SE 0.182)	0.356 (P 0.051) (SE 0.182)			0.331 (P 0.072) (SE 0.184)	0.359 (P 0.050) (SE 0.183)
8. Share of gross capital formation			-0.046 (P 0.733) (SE 0.135)	-0.019 (P 0.888) (SE 0.137)			-0.048 (P 0.725) (SE 0.136)	-0.019 (P 0.892) (SE 0.137)
9. Share of merch. exports			0.113 (P 0.282) (SE 0.105)	0.129 (P 0.226) (SE 0.106)			0.113 (P 0.284) (SE 0.105)	0.129 (P 0.224) (SE 0.106)
10. Exports from emerging market			0.049 (P 0.104) (SE 0.030)	0.060 (P 0.048) (SE 0.030)			0.048 (P 0.109) (SE 0.030)	0.060 (P 0.047) (SE 0.030)
Observations	680	680	561	561	680	680	561	561
R^2	0.063	0.056	0.196	0.195	0.064	0.056	0.196	0.192

3.3.3 Ten year U.S. Treasury yield

Table 3 shows the regression results of the relationship between the U.S. Treasury yield with a ten year maturity and real GDP per capita growth in emerging markets. Similarly to the previous two analyses all the regressions in this table include fixed individual specific effects whereas random time specific effects are only included in the regressions represented by column 2, 4, 6 and 8.

The regression results in table 3 provide weaker evidence for a negative relationship between U.S. interest rates and emerging market GDP growth than the two previous tables. This is due to the fact that the results of the linear explanatory variable are statistically significant only in columns 1-3. In comparison to the other two tables the relatively low statistical significance of the linear explanatory variable can be attributed to the fact that both adding control variables and random time specific effects greatly increased the P-values. This clearly shown by the high P-values in columns 4-8. Furthermore the marginal effect of the linear explanatory variable is negative in all cases except for column 8 where on the other hand, as just stated, the result itself is statistically non-significant due to the very high P-value. The introduction of control variables on the other hand increased the R^2 and thereby the explanatory power of the regression model as a whole. Simultaneously it decreased the marginal effect of the linear and non-linear explanatory variable. Adding random time specific effects had a minor impact on both the marginal effects and the R^2. As in the previous two tables there are no statistically significant results for the non-linear explanatory variable.

In summation the results of table 3 show that there exists a linear negative relationship, albeit a statistically relatively weaker one compared to the two previous tables, between the ten year maturity U.S. Treasury yield and the GDP per capita growth rate in emerging markets. This adds further support to the first hypothesis of this paper that there is a negative relationship between U.S. interest rates and GDP growth in emerging markets. The lack of a non-linear relationship means that this analysis emulates the two previous analyses in rejecting the second hypothesis that the marginal negative effect of U.S. interest rates on emerging market GDP growth increases as the level of U.S. interest rates themselves increases

Table 3: Relationship between the 10 year U.S. Treasury yield and real GDP per capita growth in emerging markets

Dependent variable: GDP per capita growth rate	(1) no time specific effects	(2) random time specific effects	(3) no time specific effects	(4) random time specific effects	(5) no time specific effects	(6) random time specific effects	(7) no time specific effects	(8) random time specific effects
1. 10 year US treas. Yield (Linear)	-0.413 (P 0.000) (SE 0.109)	-0.413 (P 0.005) (SE 0.147)	-0.239 (P 0.046) (SE 0.120)	-0.233 (P 0.147) (SE 0.161)	-0.556 (P 0.269) (SE 0.503)	-0.556 (P 0.419) (SE 0.688)	-0.080 (P 0.877) (SE 0.515)	0.053 (P 0.941) (SE 0.714)
2. 10 year US treas. yield^2 (Non-linear)					0.009 (P 0.770) (SE 0.032)	0.009 (P 0.831) (SE 0.044)	-0.021 (P 0.525) (SE 0.032)	-0.019 (P 0.681) (SE 0.045)
3. Local interest rate in emerging market			0.000 (P 0.208) (SE 0.000)	0.000 (P 0.179) (SE 0.000)			0.000 (P 0.205) (SE 0.000)	0.000 (P 0.178) (SE 0.045)
4. Employment rate			-0.172 (P 0.512) (SE 0.262)	-0.146 (P 0.574) (SE 0.260)			-0.171 (P 0.516) (SE 0.262)	-0.145 (P 0.579) (SE 0.261)
5. Capital stock			0.317 (P 0.000) (SE 0.044)	0.316 (P 0.000) (SE 0.044)			0.316 (P 0.000) (SE 0.044)	0.316 (P 0.000) (SE 0.044)
6. Exchange rate, loc. currency/USD			0.006 (P 0.581) (SE 0.010)	0.006 (P 0.585) (SE 0.010)			0.005 (P 0.647) (SE 0.011)	0.005 (P 0.616) (SE 0.011)
7. Share of gov. consumption			0.331 (P 0.070) (SE 0.182)	0.359 (P 0.049) (SE 0.182)			0.347 (P 0.060) (SE 0.184)	0.368 (P 0.045) (SE 0.183)
8. Share of gross capital formation			-0.043 (P 0.749) (SE 0.136)	-0.017 (P 0.900) (SE 0.137)			-0.052 (P 0.704) (SE 0.136)	-0.020 (P 0.883) (SE 0.138)
9. Share of merch. exports			0.114 (P 0.279) (SE 0.105)	0.130 (P 0.223) (SE 0.106)			0.113 (P 0.286) (SE 0.106)	0.129 (P 0.224) (SE 0.106)
10. Exports from emerging market			0.048 (P 0.111) (SE 0.030)	0.060 (P 0.049) (SE 0.030)			0.046 (P 0.124) (SE 0.030)	0.060 (P 0.050) (SE 0.030)
Observations	680	680	561	561	680	680	561	561
R^2	0.063	0.056	0.193	0.191	0.063	0.063	0.194	0.191

3.3.4 Summary of results

Altogether the findings of the three regression analyses provide us ample evidence that there does exist a negative relationship between U.S. interest rates and economic growth in emerging markets. This has implications for the way we should observe and understand the complex link between American monetary policy and the growth prospects of developing countries. When the U.S. Federal Reserve decides on the level of the Federal Funds Rate it does so on a national mandate, allegedly based on a mainly domestically oriented analysis focused on economic issues in the United States. As shown in this paper the impact of that decision is however by no means purely national but truly global, the effects of which are felt more so in emerging markets than elsewhere. For that very reason it is imperative that

the negative relationship, supported by the results in this paper, of U.S. interest rates on emerging markets remains a focus of further analysis.

The lack of a non-linear negative relationship between U.S. interest rates and emerging market GDP growth makes it easier to anticipate how developing countries will be affected by rising interest rates. This is because the linearity implies that the marginal effect of rising interest rates is constant and does not change depending on the level of the interest rates themselves. The constant negative marginal effect makes it easier to foresee the change in the economic growth trajectory of emerging markets stemming from rising U.S. interest rates.

The fact that the results in two out of three analyses are statistically significant when including both individual and time specific effects as well as control variables add credibility to our findings. Having taken into account both economic factors typical for individual countries as well as more overarching macroeconomic trends affecting all countries equally minimizes the risk that the results are spurious in the sense that they are determined by variables omitted in our analysis.

Lastly the differences in statistical significance of the regression results generated by our different explanatory variables could indicate that more short-term U.S. interest rates have a greater negative impact on emerging market growth than do more long-term interest rates. Whereas all three explanatory variables had fairly similar marginal effects the statistical significance of the short-term Federal Funds Rate was greater than that of the more long-term two year maturity yield which in turn was more statistically significant than the even longer term ten year maturity yield. The higher the statistical significance the more credible the established negative effect on emerging market growth and thus one could argue that the most short term interest rate, the Federal Funds Rate, has the greatest negative marginal effect on emerging market growth. The underlying reasons for this would be an interesting topic for another paper. One of the reasons for this could be the fact that the ten year U.S. Treasury yield has a much more long-term anticipatory horizon on the economy as opposed to the Federal Funds Rate which focuses on the current economic situation.

4 Conclusion

The linear negative relationship of U.S. interest rates on emerging markets supported by the findings in this paper raises questions as to how these countries will be affected if the U.S. Federal Reserve continues to raise the Federal Funds Rate. Although the U.S. interest rates remain relatively low and some even believe that the Federal Reserve will soon start lowering the rate again it is safe to say that the current low interest rate environment won't last forever (Cox, 2019). That in turn begs the question how emerging markets will react to rising interest rates and how they will handle the negative economic consequences which according to this study risk being fairly substantial if the interest rates reach high enough levels. Offering insight on this issue is (Andersson & Karpestam, 2013) who analyse how different types of financial crises affect developing countries differently. Of particular interest with respect to this paper is their finding that debt crises tend to have the most severe impact on developing countries, particularly those in Latin America and Africa. This is because one of the causal explanations in this paper behind the negative relationship of U.S. interest rates on emerging market growth was the deterioration of these of these countries' creditworthiness resulting from rising interest rates.

As a conclusion it would be interesting to see the results of a more extensive study containing these three regression analyses pursued in this paper but with a much longer time series running from the 1940's. This would be interesting because after the second world war the U.S. interest rates rose continuously over a prolonged period of time, allowing testing of the two hypotheses in a context of high interest rates as opposed to the low interest rate environment of this paper's analysis (Federal Reserve bank of St. Louis). Were the marginal effects of the explanatory variable to be negative and statistically significant also in such an extensive and long-term analysis that would indicate an even stronger negative relationship between U.S. interest rates and emerging market GDP growth.

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