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Endogenizing Total Factor Productivity: The Foreign Direct Investment channel in the case of Bulgaria (2004-2013)

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Abstract

This paper estimates the contribution of Foreign Direct Investment (FDI) to the Total Factor Productivity (TFP) of Bulgaria for the period 2004-2013. Since TFP captures the joint efficiency of capital and labor, it is likely to be influenced by investments from abroad. As predicted by theory, a positive relationship between TFP and FDI is documented. The effect of ignoring the implications of this model on the economy is explored through simulations and it is proven that this action leads to a distorted view of the growth path of the economy. The standard Ramsey (optimal) growth model, augmented with the FDI channel is used to compare the speed of convergence to an identical setup without FDI. The results of the study can serve as justification for introduction of policies and development of governmental strategies for attracting FDI inflows.

Keywords: simulation, endogenous growth, TFP, FDI

JEL classification codes: E13, E17, E22, O33

Section 1: Introduction

Foreign direct investment (FDI) is an important part of every open market economy and has been one of the more noticeable and discussed characteristics of the globalization process. FDI is a bridge between economies and is considered a tool of transferring skills, technology, and knowledge between countries. The impact of FDI is expected to be growth-enhancing through the introduction and incorporation of new inputs and technologies, which influences both human efficiency and capital efficiency. Some of the documented effects of FDI are unemployment decrease, improved welfare of the population, growth in productivity and accelerated economic growth.

The growth in productivity as a result of FDI has attracted the attention of both academic researchers and policy makers. A number of studies associate an increase Total Factor Productivity (TFP) with an increase in FDI, however, a positive relationship between FDI and TFP has not been proven unconditionally. Some studies provide proof that the impact of FDI is indeed positive, however, it seems that the results depend on the on the level of development and openness of the economy. Because FDI is seen as a key channel for transfer of greater organizational forms and technologies in industrialized and developing countries (Isaksson, 2007), an evidence of positive impact of FDI on TFP would provide justification for introduction of policies and development of governmental strategies for attracting FDI inflows.

Bulgaria is a good case for exploration of this subject as the country is a transitional one. Based on the level of development of the country, we can state that it needs to find ways of accumulating capital and knowledge. Proving that FDI is a channel satisfying these needs will encourage improvements in this direction. Furthermore, Bulgarian studies and empirical experiments are scarce, so an important objective of this paper is to provide a theoretical alternative for both policymakers and future academic researchers.

This research provides an extensive study on the existing literature on FDI, TFP and knowledge accumulation and applies the theory for the Bulgarian economy, proving the positive link between the variables. Furthermore, the measured impact is incorporated in simulations predicting the future development of the economy. The remainder of the paper is organized as follows. In Section 2, we will look at the existing literature on the connection between FDI and TFP growth including brief analysis on the results and the differences in studies. Section 3 describes the theoretical framework and the structure of the model and Section 4 describes the estimation strategy and data. Section 5 presents data analysis, econometric results and concerns. Section 6 will be used for development of predictions based on the results from Section 5 and Section 7 is reserved for conclusion.

Section 2: Literature Review

We will focus on articles and studies that describe the relationship between TFP and FDI. Even though this connection can be studied on micro level, or spillover effects of FDI in a certain sector, we will focus on the aggregate level. A few studies so far have examined the influence of FDI on TFP at macro level with predominantly positive results, however, there are several authors that argue that the variables might be negatively related. We will discuss both of these options and will proceed with the examination of the Bulgarian case.

TFP has been long perceived as an exogenous variable that is determined outside of the model and influences the output of an economy. However, this is not observed in open market economies as stated by P. Romer (1990). In his study of endogeneity of TFP, he finds that integration can increase growth, as integration to world markets means openness and possibility to invest and receive investments from abroad. This ultimately means that FDI, as the channel of moving funds between economies, would also lead to increase in growth, very similarly to the fact that presence of trade improves efficiency.

İbrahim Arısoy (2012) takes a look at the effect of FDI on both TFP and economic growth for Turkey for the period 1960–2005. His empirical results, based on regressing TFP and GDP on FDI only, show that FDI has a positive influence on both, through technological spillovers and capital accumulations. Pessoa (2005) receives positive results for a panel of OECD countries and concludes that FDI has a positive impact on a host country's TFP. He attributes this to the fact that FDI is a channel through which technologies are transferred internationally. In addition, Woo (2009) shows that for the period 1970-2000 in a large sample of countries FDI had positive effect on TFP growth.

The linkages between TFP and FDI found in the different studies vary in their nature, even if they are proven positive, especially for developing and transitional economies. For example, Zhaoyong Zhang (2002) studies the contribution of FDI to productivity growth in cross-region analysis in China for the 1984 to 1997 period, and finds a bidirectional causal linkage between FDI and TFP. The results of the study suggest that China's growth is largely due to rapid expansion of physical investment in fixed assets from FDI, and not considerably through technology transfer mainly due to inefficiency and lack of capability of assimilating the technology. FDI was invested in more labor-intensive sectors and had a positive effect on labor productivity.

Even when showing a positive link between the variables it seems that developed countries experience the effects of FDI in a different manner than the developing countries. In Keller and Yeaple's (2003) study of plants in the U.S. (1987-1996) the FDI effect was more pronounced in more technologically oriented sectors because of better communication with international companies. They attributed more than 10% increase in productivity growth to FDI spillover effects. It seems that the FDI effect get more concrete the more organized and advanced the economy is.

Nevertheless, it seems that the positive relationship most authors receive might be also country specific. Mello (1999) estimates the impact of FDI on capital accumulation, output and TFP growth and

comes to the conclusion that the FDI influence is country specific because of factors that are unobservable by time series analysis. The impact of FDI also depends on whether the receiving country is a leader or a laggard as effects of technological transfer are lower than in a still developing country. The observations are based on a time-series panel data for a sample of OECD and non-OECD countries in the period 1970-1990.

The absence of direct positive effect of FDI on TFP is usually explained by low absorption efficiency of the economy thus making it impossible for the country to benefit from increase in human capital and technology (Borensztein, 1998). Furthermore the levels of economic freedom, openness of the economy and establishment of efficient financial environment also have negative effect. For example, negative relationship between FDI and TFP has also been present in a study by Sadik and Bolbol (2001). For several developing Arab countries (Egypt, Jordan, Morocco, Oman, Saudi Arabia and Tunisia), they investigate whether FDI affects TFP through technology spillovers effects. They find that FDI has actually a “very significant and negative effect” on most of the countries included in the study. However, they establish clearly that these effects might be caused by inefficient governmental policies and institutions, lack of investment efficiency and inadequate appreciation and availability of technological innovation.

Given the inconsistencies in the literature, in this study we will propose a model that incorporates the idea that FDI has a partial effect on TFP and its effects are influenced by several related variables. Until now most studies have incorporated additional variables that have expected positive influence on TFP, however, we have decided to include aspects of the economy that could also have a negative effect on TFP.

Section 3: Model Setup

In neoclassical growth models (Solow, 1957), technological progress is seen as exogenous or outside of the model. This means that technological progress cannot be controlled or enhanced. Modern growth theory (Romer, 1990) tries to explain how progress arises or in other words tries to endogenize the variable. Thus the model is expanded to incorporate explanations for knowledge creation and accumulation. In “old models” growth was limited and uncontrollable while in the expanded version growth is maintained.

Bulgaria, which is a post-socialist country, lacked proper channels for acquiring knowledge and accumulating proper capital years after the socialist block has disbanded and the dissolution of the “iron curtain”. FDI is expected to expand the productivity of the country through labor training, skill acquisition, and introduction of alternative management practices and organizational arrangements which eventually are implemented through cooperation with foreign companies and acceptance of foreign investment. This means that we would expect the growing amount of FDI in the country to have a positive effect on the productivity. This effect has been proven for industrialized countries which have better data, but it needs to be further proven for the developing countries such as Bulgaria. The country needs to promote innovation and progress, and demonstrating that FDI is in fact a tool for achieving this goal, would promote practices for international cooperation even further.

Because, most theories suggest that FDI has a spillover effect on technological change we will take TFP as a dependent variable showing technological progress. TFP is not only a technological improvement, but also an increase of the knowledge and efficiency of a country. The method of learning-by-doing has been first developed by Arrow (1962), who incorporates the idea that changes in knowledge lead to shifts in the production function. In the model, each new machine or capital accumulated is capable of changing the environment as learning to use this capital takes place. This model, however, is oversimplified as it does not include additional variables that influence the learning

process. Nevertheless, we will base our assumptions and model on the idea that learning is increase in TFP, and occurs as a side effect of the production of new capital.

The model used in calculating the influence of FDI and proving the previously stated assumptions on the effect of FDI on TFP, is based on the above stated idea of knowledge accumulation through learning-by-doing. In this model an increase of TFP or increase of knowledge, is a function of the increase in capital. Similarly here we will assume that TFP is a function of FDI:

$$A_t = B_t F_t^\gamma \quad (3.1)$$

or

$$\ln A_t = \ln B_t + \gamma \ln F_t + \varepsilon_t \quad (3.2)$$

where A is TFP, B is a shifting parameter representing additional variables influencing TFP, F is FDI stock and γ is a parameter between 0 and 1 (based on the natural phenomenon of diminishing returns). The effect of FDI is represented by γ and we expect to find it to be positive, as we expect it to have enhancing properties. The shifting parameter is included in the model, as there are number of variables that could enhance or decrease the influence of FDI.

In the econometric analysis, the regression for this equation would take the following form:

$$\ln \hat{A}_t = a_0 + b_1 \ln F_t + b_2 X_t + b_3 \ln Y_t + b_4 \ln Z_t + \varepsilon_t \quad (3.3)$$

where $b_1 = \gamma$, F is FDI stock and X, Y, Z are control variables that lay in B and affect the effects of FDI on TFP. All variables are detrended following the methods in Section 4.

For now the additional variables we have decided to include into our regression are Government spending on Health, Education and Social protection and the spending for Research and Development. We have decided to incorporate these variables because of their probable effects on the productivity of the country. Government spending on health and education and Research and Development spending are

straight forward and are expected to have positive effect on TFP as they are intended to make the labor force more productive.

Expenditure for social protection is expected to have a negative effect on TFP as it provides an excuse for people to be absent of work thus decreasing productivity. Such expenditures cover sickness / healthcare benefits (paid sick leave, medical care and the provision of pharmaceutical products), disability benefits, old age benefits, survivors' benefits, family and children benefits (pregnancy, childbirth, childbearing and caring for other family members), unemployment benefits, housing benefits and others.

Section 4: Data

Measuring TFP could become problematic if incorrect data and methods are used. Therefore, we are going to replicate the already established method of measuring the Bulgarian TFP by Kaloyan Ganev (2005). The period he covered is 1990-2007, using yearly data; however, in this study we are going to examine quarterly data from the period 2004-2013.

As we have established, Total Factor Productivity represents technological change and productivity. It represents an additional factor that influences growth of GDP despite the relative change in capital and labor. In this study, TFP is calculated using the Cobb-Douglas production function:

$$Y_t = A_t K_t^\alpha L_t^\beta \quad (4.4)$$

In equation 4.4, Y_t represents real GDP for a time t , A_t is TFP, and L_t and K_t are labor and capital respectively. The symbols α and β represent the output elasticities of capital and labor, respectively and $\alpha + \beta = 1$, if we assume constant return to scale. A_t is the level of development for

the current year found as a residual from the equation, L_t is measured by the total number of hours worked in the current year and K_t is the real value of physical capital in the current year.

The data on labor and GDP is gathered from the National Statistical Institute in Bulgaria. Capital is calculated using the perpetual inventory method and α is received by calculating the ratio of compensation of employees and net mixed income to GDP. All data is seasonally adjusted and in real terms (2010 prices).

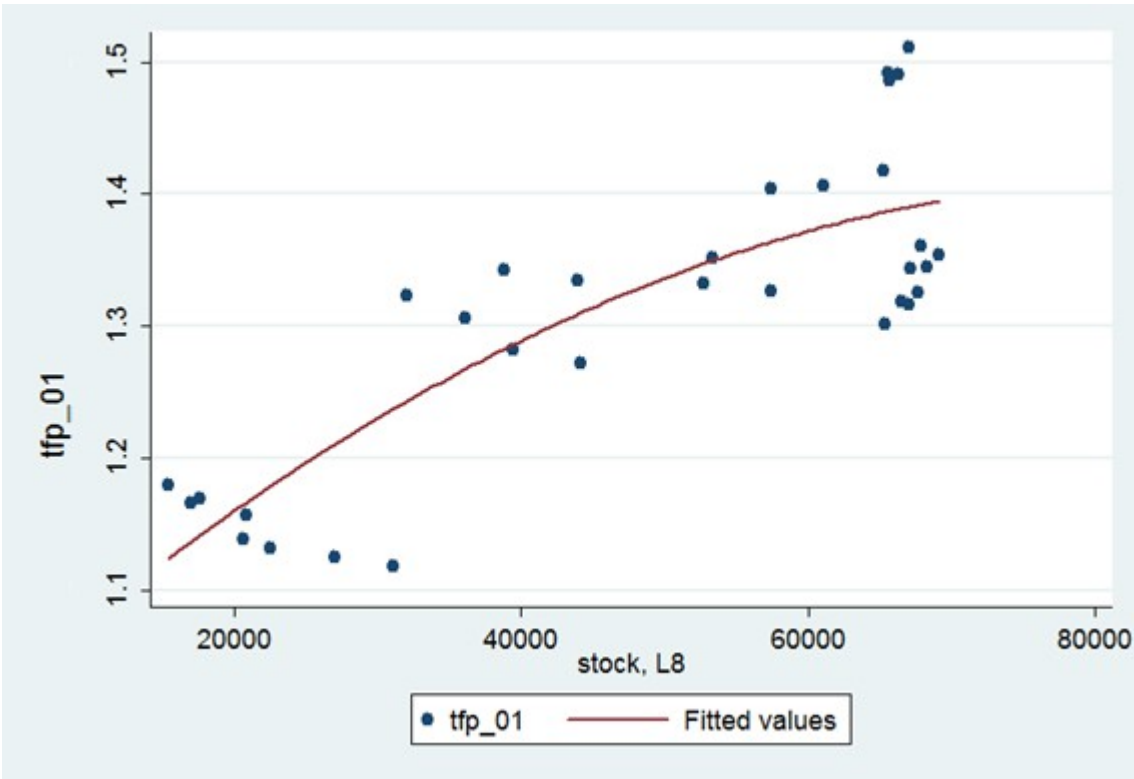
In this study we have decided to employ quarterly data of stock of FDI in millions of Bulgarian currency in real terms. The data is collected from the Bulgarian National Bank and represents stock of inward FDI. We prefer stock to flow values, because it is considered to be a better measure of the impact FDI has on TFP (Arisoy, 2012). This is due to the delay in the effect of an investment on production due to the time needed to build physical capital, teach workers to use the new equipment or incorporate a new organization structure. The literature suggests that knowledge transfers, capital accumulation and adoption of new technologies are the main channels through which FDI increases growth, however, FDI flows can rarely be incorporated at the same time they have been received.

The values for Health, Education, Social protection, and Research and Development spending are calculated using data from Eurostat. In the original dataset, the values of the variables were presented as yearly percentage of GDP, however, as we need quarterly information (unfortunately not present for either of the variables), we have calculated a time series for each variable using the quarterly variable of GDP. Because GDP is in fact in millions of Bulgarian currency, seasonally adjusted and in real terms the 4 variables are also presented in the same manner.

When creating a scatterplot of the values for TFP and the stock of FDI in Bulgaria for the period 2004-2013 (TFP values on the vertical axis and FDI values on the horizontal one) a negative relationship

for the first two years is observed. For the next 8 years a boom in the growth of TFP is present although FDI has barely increased. A reason for this might be delayed effects of FDI on TFP. In fact, if we incorporate the 8th lag of FDI stock in the same scatterplot, we receive the following graph:

Graph 1: TFP-FDI scatterplot¹



The decision to use the 8th lag is further reinforced by the idea that any investment needs time to produce results. There are several studies on the time-to-build and time-to-plan theories, with the most notorious one of Kydland and Prescott’s (1982). They have found that there is no evidence that capital goods could be built faster if more money is invested, which means that time needed for building of an investment is independent of the size of the investment. Mayer (1960) has come to the conclusion that the time to plan and finish a project was 21 months. Those studies, even though supporting the fact that time is needed for an investment to start paying off, focus on how policies could be employed to

¹ Data source - BNB (2014), authors' calculations

strengthen the production of an economy. In fact, the time for finishing a project is not specific and depends on the economy and the level of present technology.

In the case of Bulgaria, the lag taken is based on reasons connected with the bureaucracy of Bulgaria. Building permits and pre-building preparations could take up to 6 or 7 months according to several private companies in the construction industry. The Law on Public Procurement/Public Procurement Act could prolong the process with 3 to 6 months if the purchases are with value of more than BGN 100 000. Furthermore, Bulgaria is still a developing country so even if the physical capital is upgraded and new technology introduced, human capital still needs to be educated. Having Mayer's calculation and these conditions in mind, we have decided to employ a two year lag of the effect of FDI on TFP.

Section 5: Empirical results

We can start by running a regression of the pure model which has been stated in equation (3.2). In order to receive meaningful results we need to take into consideration the lag of FDI so we receive the following results:

Table 1: Regression of 8th lag of FDI on TFP

Variable	Coefficient	Std. Err	t	P> t	95% Conf. Interval	
L8.lnFDI	.147	.0179	0.000	.111	.184	.147
_cons	-1.307	.192	0.000	-1.7	-.916	-1.308
Number of observations=32		R-squared=0.692		Adj R-squared=0.6817		

Although we receive very promising results, as we have discussed in the previous section, the regression is not full as it disregards most of the additional variables that could influence TFP.

In order to correct this problem we need to run the regression of equation (3.3). Our first step is to check for stationarity of the series as many macroeconomic series may contain a unit root. -

Augmented Dickey–Fuller unit-root test. The test is based on the null hypothesis that a unit root exists in the series and in order to continue with regressing the variables we need to make the series stationary. We conduct ADF assuming the existence of trend and drift and lag of 4 because of present serial correlation. Results can be seen in table 2

Table 2: Augmented Dickey-Fuller Test with 4 lags, trend and a constant

Variable	Mackinnon p-value	Trend p-value	Const p-value
lnTFP	0.2856	0.011	0.155
lnFDI	0.1392	0.455	0.003
lnR&D	0.2439	0.012	0.011
lnHealth	0.1501	0.034	0.007
lnEducation	0.6433	0.619	0.065
lnSocialProtection	0.7569	0.179	0.098

All variables show unit roots, however, of different types. For TFP the results show existence of a trend, but no drift and for FDI the lack of trend but existence of a drift. For TFP, differencing does not solve the problem, so we employ the Hodrick–Prescott filter in order to get rid of the trend. Applying again the same ADF test we still see in the results unit roots. We try ADF without trend and constant as they appear insignificant in the previous test and receive no unit root. For FDI, we try to run ADF without trend, as it appears insignificant receiving no unit root with Mackinnon value of 0.0014. The Research and Development variable shows unit root with trend and a drift. Differencing appears to solve the problem arriving at Mackinnon value of 0.0209. For Government spending on Health differencing does not solve the problem, thus we again employ the HP filter. We do the same steps as with TFP and receive unit root free variable. For Government expenditure for Education we see the existence of unit root so we try differencing. Running the ADF test with 4 lags and trend on the differenced variable does

not solve the problem, however, we observe insignificance of the trend, lags and constant. We exclude first the trend and then the lags and receive no unit roots. For Government protection expenditures we also receive a unit root. Differencing does not help if in the test we include trend and 4 lags, however, we see that only the first lag is significant thus we again run the ADF test on the differenced variable with only first lag and no trend – the result is no unit root.

The final regression takes the form:

$$\ln TFP_t = a_0 + b_1 \ln FDI_{t-8} + b_2 \ln RD_t + b_3 \ln Health_t + b_4 \ln Education_t + b_5 \ln SocProt_t + \varepsilon_t$$

with $\ln TFP$ and $\ln Health$ detrended through the HP filter and $\ln RD$, $\ln Education$ and $\ln SocProt$ differenced. In our regressions we incorporate the 8th lag of FDI as explained in the previous section.

The results of the regression are as follows:

Variable	Coefficient	Std. Err	t	P> t	95% Conf. Indterval	
L8.lnFDI	0.03	0.02	1.97	0.059	-0.0014	0.069
D1.lnr_d	-0.09	0.25	-0.36	0.718	-0.606	.423
Detr_lnhealth	.325	.135	2.41	0.023	0.05	0.623
D1.lnedu	-0.22	0.19	-1.15	0.262	-0.627	0.172
D1.lnprot	0.607	0.244	2.49	0.019	0.106	1.108
_cons	-0.371	0.185	-2.01	0.055	-0.751	0.007
Number of observations=32		R-squared=0.4846		Adj R-squared=0.3855		

It seems that government spending on social protection which is provided to household and individuals in need actually have strong positive effect on TFP, which is contra-intuitive. An explanation for this might be that because the government provides funds to those that are unable to produce, their families have more freedom to be more focused on their work place and be more productive. The

research and development and educational expenditure appear insignificant and if excluded from the regression we receive an Adjusted R-squared of 0.4004, significant FDI and coefficient of FDI of 0.0359764. This coefficient is fairly low, however, showing moderate correlation. Because of the low Adjusted R-squared, the model shows to have internal problems that are most probably derived from the insufficient data. Nevertheless, we will accept the result as even though they are close to 0 they are positive and establish a low threshold for the application of the model in the next Section. The upper threshold of the model would be the pure regression of FDI on TFP which we did in the beginning in the section with a result of 0.15. Both results would be used to establish the effects of the model on the economy, and provide simulation evidence that ignoring the implications of it could lead to a distorted view of the growth path of the economy.

Section 6: Application of the model in practice

In the previous sections we have considered a model which shows a positive dependency between TFP and FDI. However, we need to take our focus back and see the bigger picture when it comes to TFP and output. Because TFP plays an essential part in the production function we need to reconsider the model in its context. In this section, we use a standard Ramsey (optimal) growth model, augmented with the FDI model described before, to compare the speed of convergence to an identical setup without FDI. The results will show that there will be differences in terms of time needed to reach the steady state in the presence of an FDI and by ignoring the FDI channel.

We have mentioned the Solow model and we have extensively discussed the Cobb-Douglas production function, so we cannot ignore one of their main applications – finding the steady state of an economy. In our simulation we employ optimization techniques with respect to consumption and capital accumulation. We incorporate the TFP/FDI model in order to see whether an economy taking into consideration FDI would reach its steady state faster or slower.

First, let us explain the optimization methodology. The economy is run by people and people strive to maximize their utility from consumption. To maximize the utility of a lifetime, the people need to maximize their consumption or in other words consume the output and capital depreciated in such a way that sustainability is achieved in the presence of investments. However, we need to take into consideration the fact that for people current consumption is more important than future consumption. This means that future consumption needs to be discounted to its present value. Stating those facts into an equation gives us:

$$\max_{\{c_t, k_t\}} \sum_{t=0}^{\infty} b^t \ln(c_t) \quad (6.1)$$

where $\ln(c_t) = U(c_t)$ and b is a discount factor such that $0 < b < 1$ as human beings consider consumption at early times more valuable than consumption further in the future.

Equation 6.1 is subject to several constraints. Output can be either consumed or invested and the goal is to find the best allocation between the two choices that will maximize the utility of the people in perpetuity. We can represent this statement with several equations:

$$y_t = c_t + i_t \quad (6.2)$$

$$k_{t+1} = (1 - \delta)k_t + i_t \quad (6.3)$$

$$y_t = A k_t^\alpha \quad (6.4)$$

All of the variables are in per capita terms with population stable overtime. Equation 6.2 represents the allocation between consumption and investment. Here output also plays the role of income and investment – or savings. In equation 6.3 the capital stock of the future period is equal to the depreciated capital stock of the current period plus the investments made in the current period. The third

equation 6.3 represents the output produced in period t from the capital per worker using the technology for the period. The combination of the three equations gives us the equation that depicts the aggregate consumption in the economy and the constraint to equation 6.1:

$$c_t = (1 - \delta)k_t + Ak_t^\alpha - k_{t+1} \quad (6.5)$$

The results of 6.1 have already been expressed in the Euler equation which is a fundamental basis in intertemporal optimization problems with dynamic constraints. The resulting equation is:

$$\frac{U'(c_t)}{bU'(c_{t+1})} = \frac{\alpha Ak_{t+1}^{\alpha-1} + 1 - \delta}{1} \quad (6.6)$$

We can interpret equation 6.6 as the connection between intertemporal rate of substitution of consumption and the marginal rate of transformation of capital. In other words, every time a person makes the decision to invest or save their capital for the next period they consciously take the decision to substitute consumption for saving in order to achieve higher consumption in the future. On the other hand, they receive a return on the invested capital minus the lost capital due to depreciation.

In the long-term version, the consumptions levels in period t and in period $t+1$ must be equal, thus the utility throughout the periods must be constant. This means that:

$$1/b = \alpha Ak_{t+1}^{\alpha-1} + 1 - \delta \quad (6.7)$$

where $\alpha Ak_{t+1}^{\alpha-1} + 1 - \delta$ represents the real return on investment after depreciation. Overall, the idea behind both equations 6.6 and 6.7 is that in order for the people to choose to invest they need to receive an additional return or compensation in the next period in order for the utility to stay stable.

In connection with equation 6.6 we need to take into consideration the empirical fact for balanced growth, that in order to have every component growing with the same rate, the utility function of consumption should be restricted to be of the CES (constant elasticity of substitution) form or:

$$U(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma}$$

and

$$U'(c_t) = c_t^{-\sigma}$$

From here we can restate equation 6.6 to be:

$$c_{t+1}/c_t = [b(\alpha A k_{t+1}^{\alpha-1} + 1 - \delta)]^{1/\sigma} \quad (6.8)$$

and we can easily express the consumption in one period through the consumption in the adjacent one. The intertemporal elasticity of substitution or $1/\sigma$ shows how responsive is the growth rate of consumption to the changes in the real interest rate. If the elasticity is high ($\sigma < 1$) then consumers are willing to sacrifice more of their current consumption for their future consumption as a result of increase in interest rates. If the elasticity is low ($\sigma > 1$) the consumption smoothing motive is strong, thus consumers are not willing to substitute current for future consumption so easily and would decide to consume instead of save if the real interest rate is high.

Finally, the so-called Transversality condition (TVC) has to be imposed. It is a boundary condition that rules out explosive paths, and guarantees stability of the equilibrium paths for capital, consumption, investment and output. It necessitates that at the end of the optimization horizon the discounted value of capital is zero.

$$\lim_{t \rightarrow \infty} b^t U'(c_t) k_{t+1} = 0$$

In the long run we are expected to meet the steady state where there is a constant capital stock. This means that from equation 6.7 we can omit the period identifications and rearrange the equation in order to receive the steady state capital value:

$$k^c = \left[\frac{\frac{1}{b} + \delta - 1}{\alpha A} \right]^{\frac{1}{\alpha-1}}$$

We assume that k_0 is given as a percentage of the steady state – we will assume that the economy starts at 10% of the steady state. We know what our optimal results are, so we are interested at what point of time we are going to reach these optimal results. We translate all of our findings and equations into a simulation that is going to show us at what point the Bulgarian economy is going to reach its steady state using the optimization method for consumption. The simulation is made with MATLAB2015 and could be provided upon request.

In order to incorporate the model discussed in the previous sections we are going to assume that the capital of FDI is included in the overall capital and the problem is that economists are understating its influence on the productivity, thus do not account for it. This means that we have to restate our production function to:

$$y_t = B k_t^{\alpha+\gamma}$$

since

$$A = B k_t^\gamma$$

The stationary parameters used are as follows:

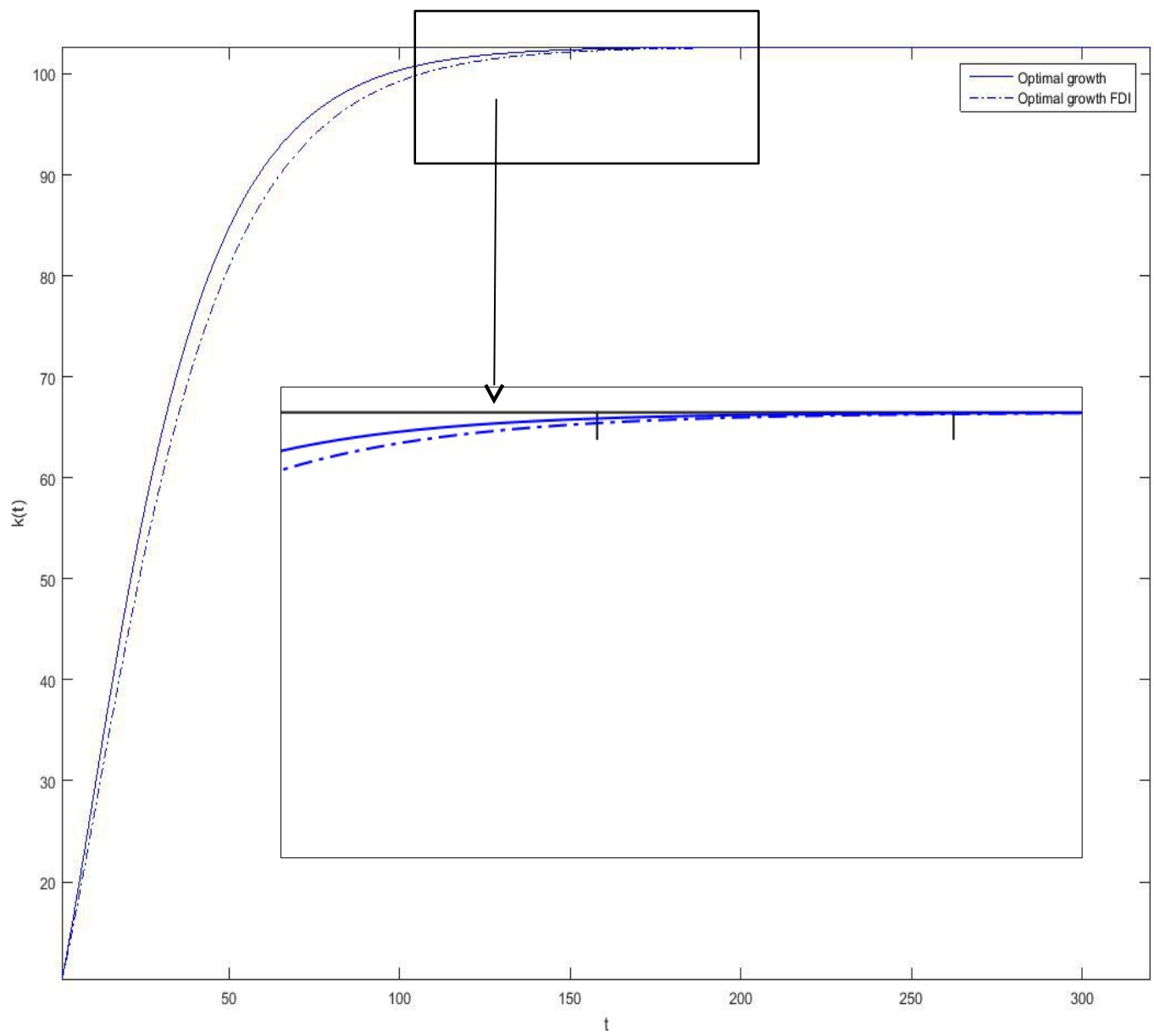
A	δ	α	b	γ_1	γ_2	σ
1.5	0.05	0.55	0.95	0.03	0.15	1.5

Where b has been calculated on the basis of a return of capital of $\alpha A k_{t+1}^{\alpha-1} = 1$ and the value for σ has been based on estimates of Hansen and Singleton (1983) and chosen to reflect the general

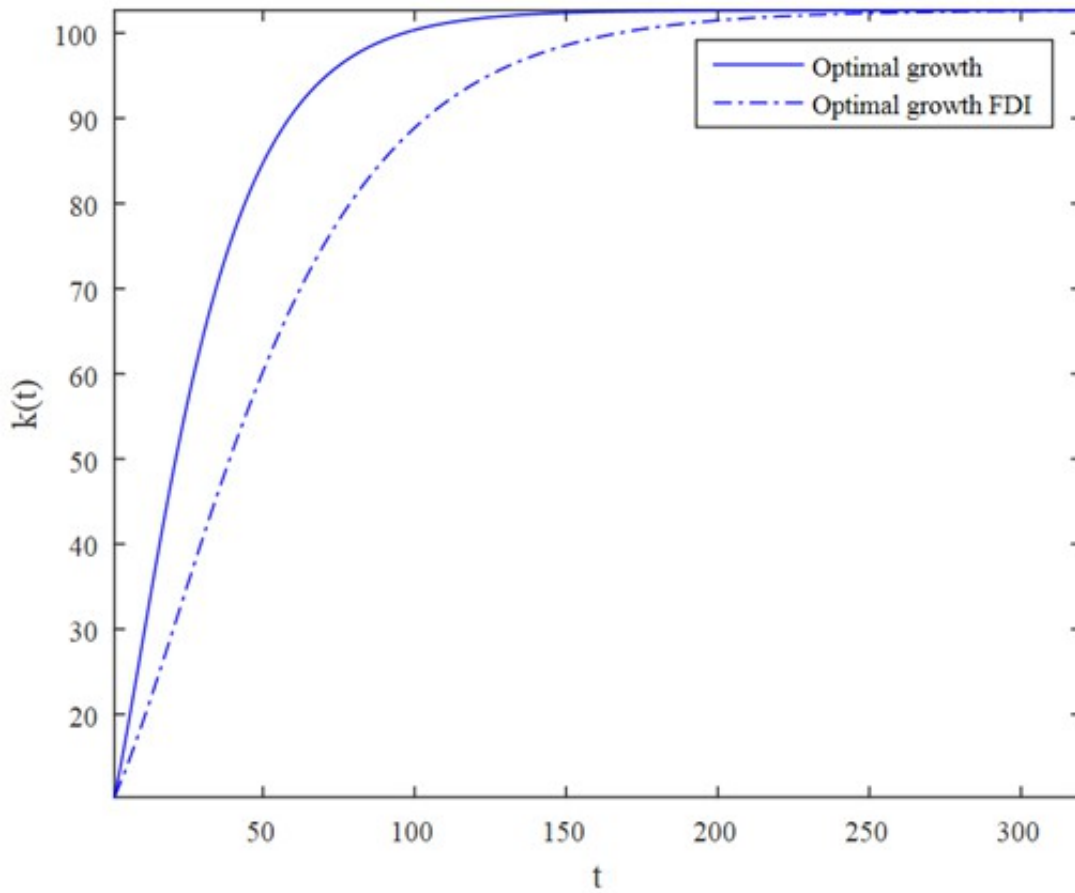
tendencies of Bulgaria and the risk aversion of the population. TFP and α are taken as averages from our previous findings and $\gamma_1 \wedge \gamma_2$ are results from our econometric analysis. Nevertheless, the model can easily be adapted to simulate different economic variables. We need to address the fact that B is calculated on the basis of k^* although it is present in the model including FDI. We have decided to do so because in both simulations the economy is converging towards the same steady state, but with different speeds which is what we are interested in

A graphical representation of the results is as follows:

Graph 4: Application of the model: simulation with γ_1



Graph 4: Application of the model: simulation with γ_2



Both results show that the time needed to reach the steady state, considering the effects of FDI, is longer which means that by ignoring it, the standard Ramsey model is underestimating the actual time needed for the economy to converge to the steady state, no matter the value of γ . The reason for this increase in time lies in the increased marginal product of capital when we consider the effects of FDI. This means that reinvestments and updates are needed after a longer period or smaller quantities, thus increasing the time of convergence. This result is also consistent with the observed delay of investment becoming productive.

Section 7: Summary and Conclusion

FDI is considered one of the levers that push an economy forward by increasing the productivity of a country. The literature, however, is still showing up results that in some cases FDI actually has

negative influence on TFP. This study argues that the differences come from underspecified models as well as econometric estimation problems and aims to provide a stepping stone for further development of policies and programs for attracting FDI. In order to solve those problems, we analyze Bulgarian data for the period 2004-2013, employing a model that assumes that TFP or increase in knowledge is a function of new capital or FDI (learning-by-doing approach).

In our study, we have provided a model that not only studies the relationship between FDI and TFP, but also incorporates additional variables in the empirical results that might influence the before stated relationship. By doing so, we find support that FDI has a positive influence on TFP in the way that the model proposes. We find that in fact FDI has a lagged effect on TFP which could easily change the way policy makers see foreign investments and their effects.

We come to the conclusion that FDI influences TFP in a positive way, but not in a strong manner. We can speculate on what could be the reason for this and the most obvious one is that Bulgaria is still a developing country, and it still does not have the proper channels to take full advantage of the incoming investments. The fact that not every industry in the country receives investments from abroad might limit the actual inflow, which could further influence the empirical results decreasing the influence on TFP. Of course, we cannot ignore the fact that the data available for research is limited so the empirical results might incorporate the consequences of the lack of information.

We conclude our study by applying the augmenting qualities of FDI to an optimal growth model, in order to find the effects on the growth path of the economy on its way to convergence to its steady state. The results show unequivocally that no matter the value of the effect of FDI on TFP the speed of convergence, in comparison to speed where we do not account for FDI, appear longer. Thus we make the conclusion that by ignoring the FDI effects, the standard optimal growth model distorts the view of the economy and presents an unrealistic time frame.

By using those findings, the reader should be able to understand better the important role of Foreign Direct Investment on the productivity of Bulgaria. By revealing the relationship between FDI and TFP, policy makers, politicians as well as government officials and economists should be able to reevaluate their positions regarding capital from abroad. We hope that findings similar to ours, would encourage future studies on the topic as well as positive development of the Bulgarian international standing regarding FDI. We firmly believe that facilitating the ease of assimilation of foreign capital would boost the economy and would positively influence the future improvement of the country.

Appendix 1: Capital

The Gross Domestic Product published by the National Statistical Institute (NSI) has been used as a measure of Y, and the hours worked by the employed persons again published by (NSI) - as a measure of L. Data on K are not published thus it is calculated additionally through the ‘perpetual inventory method’ or:

$$K_t = I_t + (1 - \delta) K_{t-1} \quad (1)$$

In this equation, I_t represents total current investment and δ is the depreciation rate. A problem occurs in the calculation of the initial capital - K_0 . The method used for calculation of the initial capital is described in equation (2) - the initial capital equals the ratio of initial investment to the depreciation rate. For initial capital we take the gross fixed capital formation and depreciation δ of 5%.

$$K_0 = \frac{I_0}{\delta + g} \quad (2)$$

We assume that the growth rate g of investments in long periods is 0 because of high volatility in the years between 1991 and 2014 (Ganev, 2015)

In order to be able to compute TFP we also need to find the values of α and β . We take advantage of the assumption that $\alpha + \beta = 1$, thus we need to find only one of the two. We use the ratio of Labor cost to GDP in order to receive α . Labor cost is calculated as Average wage per hour multiplied by the hours worked in the year. The average wage is in 2010 prices and is taken from the National Statistical Institute.

Appendix 2: Seasonality adjustment

Seasonality adjustment of the data is done by using a central moving average. The only data that this method is used is Labor. We deal with quarterly data, so the periodic effect has a period of 4 observations. We calculate the central moving averages for each observation (excluding the first and last 2) following the formula:

$$CMA = \frac{Y_{n-2}}{8} + \frac{Y_{n-1} + Y_n + Y_{n+1}}{4} + \frac{Y_{n+2}}{8}$$

which represent our central moving average for the first 5 observations.

We continue by calculating ratios between each observation and its CMA. This shows us how the observation varied from the CMA. We then calculate the 4 quarterly unadjusted seasonal indexes – each represents an average of the ratios for each quarter in each year (the average of all first quarter ratios, the average of all second quarter ratios, etc.) and these will give us the average percentages of deviations in each quarter that we see in our data. We divide each of the indexes by the average of the four receiving adjusted seasonal indexes that would prevent some statistical errors. In order to finally receive our deseasonalized data we divide each observation by its respective adjusted seasonal index.

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