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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. As predicted by theory, a positive relationship between TFP and FDI is documented. 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. Convergence simulations prove that ignoring the implications of this model leads to a distorted view of the growth path of the economy. The results of the study can serve as justification for development of governmental strategies for attracting FDI inflows.

Keywords: simulation, endogenous growth, TFP, FDI

JEL classification codes: E13, E17, E22, O33

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Section 1: Introduction

Foreign direct investment (FDI) is an inevitable consequence of having an open-market economy and its effect on economic growth has been one of the more noticeable and discussed topics in the past several decades. FDI is a bridge between economies and is considered a tool for 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 of technologies, which influences both labor and physical capital efficiency. Some of the documented effects of FDI are unemployment decrease, improved welfare of the population, growth in productivity (TFP) and accelerated economic growth.

A number of studies associate an increase in 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 level of development and openness of the economy. Because FDI is seen as a key channel for transfer of more advanced 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 expansion 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 a brief review of 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. We will include brief analysis of the results of the studies and comment on the differences between them. 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 conclusions.

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 in the standard output model. This, however, is not observed in open market economies as stated by 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. An inference we can make from this finding, is that FDI, as the channel of moving funds between economies, would also lead to increase in productivity growth, very similarly to the fact that presence of trade improves efficiency.

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 positive linkages between TFP and FDI vary in their nature especially for developing and transitional economies. For example, 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. This is a result of inefficiency and lack of capability of assimilating the technology. Nevertheless, FDI that was invested in

more labor-intensive sectors 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 US (1987-1996) the FDI effect was more pronounced in more technologically oriented sectors because of better communication with international companies. They attribute more than 10% increase in productivity growth to FDI spillover effects. It seems that the FDI effect gets more concrete the more organized and advanced the economy is.

Likewise, the positive relationship authors receive can be 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 depends on whether the receiving country is a leader or a laggard as effects of technological transfer are lower 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 *et al.*, 1998). Furthermore, the levels of economic freedom, openness of the economy and establishment of efficient financial environment also play important role. For example, negative relationship between FDI and TFP has 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 had actually a “very significant and negative effect” on most of the countries included in the study. However, they establish clearly that these results 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, we will propose a model that is based on the idea that FDI has an effect on TFP; however, we will not exclude additional variables that could influence TFP. Until now, most studies have incorporated additional variables that are expected to have positive influence on TFP; however, we have decided to include aspects of the economy that could also have negative effect on TFP.

Section 3: Model Setup

In neoclassical growth models (Solow, 1956), technological progress is modelled as being determined outside of the model and in the absence of exogenously growing TFP, growth monotonically decreases and asymptotically goes to zero, as the economy converges to the steady state. Modern growth theory (Romer, 1990) tries to explain how progress arises and therefore be enhanced - in other words tries to endogeneize the variable. For that purpose the neoclassical model is expanded to incorporate explanations for knowledge creation and accumulation.

Bulgaria is a perfect case for application and study of the modern view over technological change, as the country had to go through a process of knowledge and capital accumulation in order to come out of the crisis in the 1990s. After the disbandment of the communist block and the dissolution of the “iron curtain”, Bulgaria

faced the challenge of acquiring, developing and accumulating modern knowledge and capital. As many post-communist countries, a combination of economic failures, lack of understanding of the principles of market economy and selfish practices of the political leaders lead the country to hyperinflation in 1997. The economic conditions did not start improving significantly until the early 2000s. The country was forced to open its market to the western influence and FDI was one of the channels to achieve that.

FDI was expected to expand the productivity of the country through labor training, skill acquisition, and introduction of alternative management practices and organizational arrangements. These were expected to be 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 had a positive effect on the productivity. This effect has been proven for some 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 idea of learning-by-doing and its economic implications was developed and expanded by Arrow (1962), who incorporated the notion 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:

$$A_t = B_t F_t^\gamma e^{\varepsilon_t} \quad (1)$$

or

$$\ln A_t = \ln B_t + \gamma \ln F_t + \varepsilon_t, \quad (2)$$

where A is TFP in stationary form (as discussed in section 5), 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 to rival production factors). An important note that needs to be added is that for this model we take FDI as an exogenous variable. We have taken FDI as exogenous, simply because Bulgaria is a small open economy that does not have important imprint on the world's economy. While true that FDI's endogeneity is an important topic that needs further exploration, its research is not the primary purpose of this study.

In this study we have decided to employ quarterly data of stock of FDI in millions of Bulgarian currency in real terms (2010 prices). We preferred the stock values due to the existent 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. As FDI flows can rarely be incorporated in the existent system at the same time they have been received, we consider stock to be a better measure of the impact of FDI on TFP (Arisoy, 2012). In the model of this paper, and due to data limitations (we cannot distinguish between investment vs. non-investment), we assume all FDI is structural. Thus, our results are to be taken as an upper bound effects on TFP.

The effect of FDI is represented by γ in the presented model 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:

$$\ln\widehat{A}_t = a_0 + b_1 \ln F_t + b_2 X_t + b_3 \ln Y_t + b_4 \ln Z_t + \varepsilon_t \quad (3)$$

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 de-trended following the methods in Section 5.

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 (R&D)¹. We have decided to incorporate these variables because of their probable effects on the productivity of the country. Government spending on health, education and R&D 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

¹ Due to its small size, government spending on R&D always needs to be used cautiously in regressions. Nevertheless, it varies sufficiently for the figure to be individually significant in the regression. In addition, the F-test for joint significance cannot reject the joint importance of R&D and the remaining right-hand-side variables. Dropping R&D could bias the FDI coefficient estimated downward.

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. Unemployment benefits are relatively small part of expenditure on social protection. A much larger share take social pensions, widow's benefits, invalidity pensions, children benefits, in-kind benefits (energy subsidies, timber, electricity vouchers, food stamps, food packages, etc.). For example invalidity pension is for life, and is much more generous than the unemployment payout, which makes it more attractive to non-workers and could lead to some embezzlement schemes.

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 Ganev (2005). The period he covered is 1991-2003, using yearly data; however, in this study we are going to examine quarterly data from the period 2004-2013. The period was selected because its start corresponds with the increase in structural FDI in Bulgaria. Given that data is quarterly, we decide to take an earlier end point, in order to avoid problems with later revisions of data.

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:

$$Y_t = A_t K_t^\alpha L_t^\beta \quad (4)$$

In equation (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 $\alpha + \beta = 1$ as 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 (Appendix 1) 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) – the process of adjustment could be found in Appendix 2. The data on FDI stock is collected from the Bulgarian National Bank and represents only the stock of inward FDI for the studied period.

The values for Health, Education, Social protection, and R&D 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 the possible delayed effects of FDI on TFP. In fact, if we incorporate the 8th lag of FDI stock in the same scatterplot (equal to two year gap), we receive the graph in Figure 1, which supports the claims of positive relationship between the variables.

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 prominent one of Kydland and Prescott's (1982). Although we are aware that they are not the first to make this observation, we choose their reference because those authors were the first to operationalize the mechanism in a dynamic general equilibrium context. 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 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. Pre-building preparations and building permits 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

Our first step is to check for stationarity of the series as many macroeconomic series may contain a unit root by using 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.

All variables show unit roots; however, we take into consideration the differences in the variables and simply readjust the test. For TFP the results show existence of a trend, but no drift. Differencing does not solve the problem, so we employ the Hodrick–Prescott filter in order to get rid of the trend. Given the number of right-hand-side variables in the regression, and a sample of 40 observations, we cannot get sensible estimates when more than one lag is included. In addition, the HP filter approach was chosen to make the results comparable to the other papers in the literature. Readjusting the ADF test and running it again results in stationarity of the variable.

For FDI, we try to run ADF without trend, as it appears insignificant in the initial test, receiving no unit root. The Research and Development, Government expenditure for Education and Government Protection expenditures variables show unit roots which are brought to stationarity using differencing. For

Government spending on Health, differencing does not solve the problem, thus we again employ the HP filter which makes the series stationary.

We can start by running a regression of the pure model which has been stated in equation (2). In order to receive meaningful results we take into consideration the lag of FDI. The results of the regression of TFP on FDI (8th lag of FDI) can be seen in Table 1. Although we receive very promising results, supporting the claims 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), which takes the form:

$$\ln TFP_t = a_0 + b_1 \ln FDI_{t-8} + b_2 \ln RD_t + b_3 \ln Health_t + b_4 \ln Education_t + b_5 \ln SocProt_t + \varepsilon_t, (5)$$

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 can be found in Table 3.

It seems that government spending on social protection, which is provided to household and individuals in need, actually has strong positive effect on TFP, which is counter intuitive. An explanation for this might be that because the government provides funds to those that are unable to produce, their families have the freedom to be focused on their work and be more productive. The research and development and educational expenditures appear insignificant and if excluded from the regression an Adjusted R-squared of 0.4004, significant FDI and coefficient of FDI of 0.0359764 are received. This coefficient is fairly low, however, shows moderate correlation. Because of the low Adjusted R-squared, the model signals the existence of 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 TFP on FDI which we did in the beginning of the section with a result of 0.15². 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: Simulations for Bulgaria

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. 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 this class of exogenous growth without exogenous exponential growth in the TFP, growth is monotonically decreasing along the transition path and approaches zero as the economy converges to its steady-state. 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. We incorporate the TFP/FDI model in order to see whether an economy taking into consideration FDI would reach its steady state

² We take the estimate as an upper bound for the effect, thus the results are to be taken with “a grain of salt.”

faster or slower. The results will show that there will be differences in terms of time needed to reach the steady state in the presence of the FDI augmentation and by ignoring the FDI channel. In our simulation we employ optimization techniques with respect to consumption and capital accumulation.

First, let us explain the optimization methodology. The representative agent maximizes total discounted utility, which is a function of consumption. In other words, the agent needs to select the optimal path of consumption over time or alternatively allocate output between consumption and capital accumulation (investment) over time. An equation stating those facts is:

$$\max_{\{c_t\}} \sum_{t=0}^{\infty} b^t U(c_t) \quad , \quad (6)$$

where $U(c_t)$ is the instantaneous utility function 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.

The constraint to equation (6) is equation (7) that depicts the aggregate consumption in the economy, which depends on undepreciated capital stock remaining after the current period, the output produced in period t from the capital per worker using the technology for the period and the future capital stock:

$$c_t = (1 - \delta)k_t + Ak_t^\alpha - k_{t+1} \quad (7)$$

The results of equation (6) have already been expressed in the Euler equation which is a fundamental basis in intertemporal optimization problems with dynamic constraints:

$$\frac{U'(c_t)}{bU'(c_{t+1})} = \frac{\alpha Ak_{t+1}^{\alpha-1} + 1 - \delta}{1} \quad (8)$$

We can interpret equation (8) as the connection between intertemporal rate of substitution of consumption and the marginal rate of transformation of capital. In steady state, the consumption

levels in period t and in period $t+1$ must be equal, thus the utility throughout the periods must be constant:

$$1/b = \alpha Ak_{t+1}^{\alpha-1} + 1 - \delta, \quad (9)$$

where $\alpha Ak_{t+1}^{\alpha-1} - \delta$ represents the real return on investment after depreciation. Overall, the idea behind both equations (8) and (9) 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 (8) 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:

$$U(c_t) = \frac{c_t^{1-\sigma} - 1}{1-\sigma}, \quad (10)$$

and

$$U'(c_t) = c_t^{-\sigma}. \quad (11)$$

From here we can restate equation (8) to be:

$$c_{t+1}/c_t = [b(\alpha Ak_{t+1}^{\alpha-1} + 1 - \delta)]^{1/\sigma}, \quad (12)$$

and we can easily express the consumption in one period through the consumption in the adjacent one. The intertemporal elasticity of substitution or $1/\sigma$ depends on how responsive is the growth rate of consumption to the changes in the real interest rate.

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.

$$\lim_{t \rightarrow \infty} b^t U'(c_t) k_{t+1} = 0 \quad (13)$$

In the long run we are expected to meet the steady state where there is a constant capital stock. This means that from

equation (9) we can omit the period identifications and rearrange the equation in order to receive the steady state capital value:

$$k^* = \left[\frac{1 + \delta - 1}{\alpha A} \right]^{\frac{1}{\alpha - 1}}. \quad (14)$$

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:

$$y_t = Bk_t^{\alpha + \gamma}, \quad (15)$$

since

$$A = Bk_t^\gamma \quad (16)$$

The stationary parameters used are stated in Table 4, where b has been calculated on the basis of a return of capital of $\alpha Ak_{t+1}^{\alpha-1} = 1\%$ 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 γ_1 and γ_2 are results from our econometric analysis. Nevertheless, the model can be easily adapted to simulate different economic

variables. We also 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.

Figure 2 and Figure 3 are a graphical representation of the results. Both graphs 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 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) (Hall *et al.*, 1999) - 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% (Ganev, 2015).

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

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 the 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 centered 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 centered 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 centered 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 de-seasonalized data we divide each observation by its respective adjusted seasonal index.

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Tables

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

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		

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

Table 3: Regression of expanded model including control variables

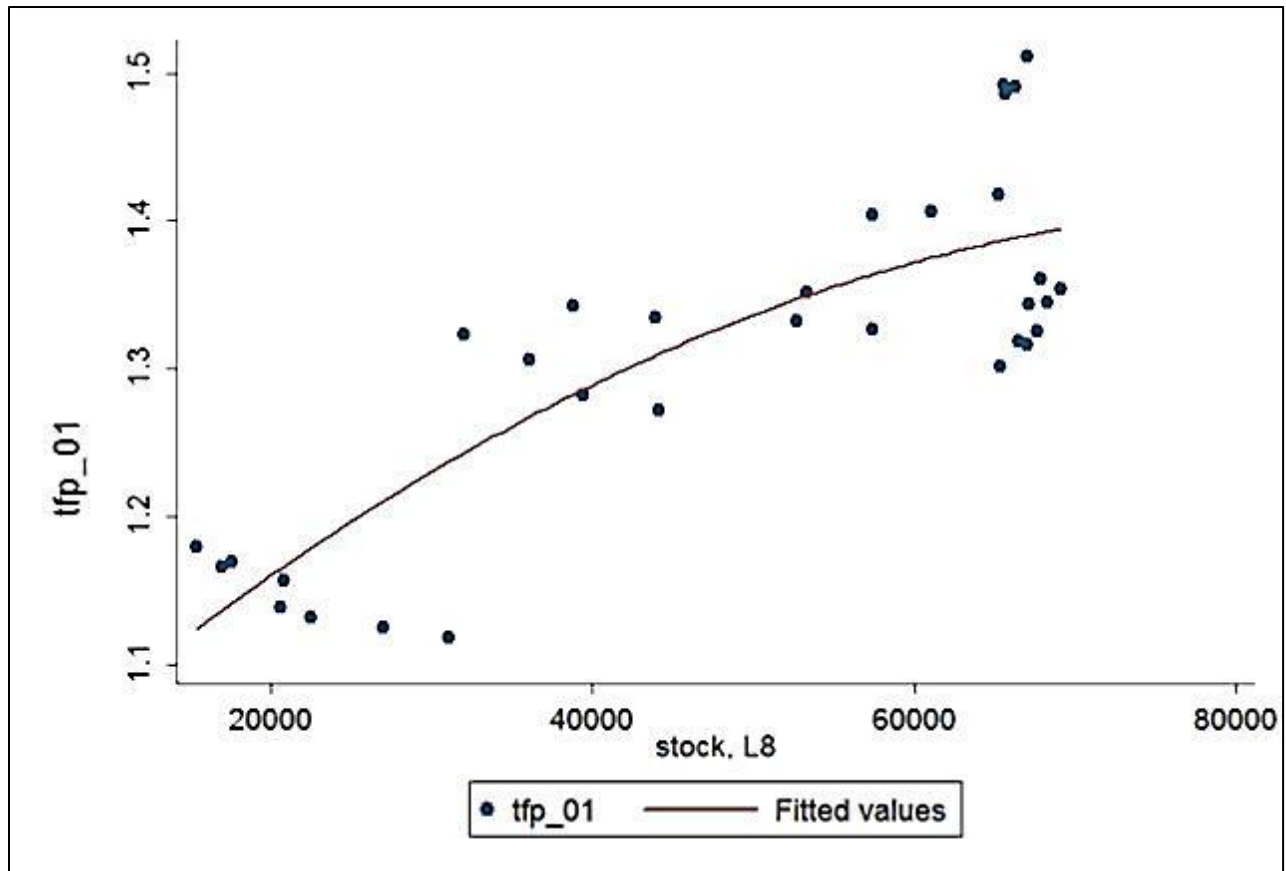
Variable	Coefficient	Std. Err	t	P> t	95% Conf. Interval	
L8.lnFDI	0.03	0.02	1.97	0.059	-0.0014	0.069
D1.lnr_d	-0.09	0.25	-0.36	0.718	-0.606	.423
Detr_Inhealth	.325	.135	2.41	0.023	0.05	0.623
D1.lnedu	-0.22	0.19	-1.15	0.262	-0.627	0.172
D1.lnprot	0.607	0.244	2.49	0.019	0.106	1.108
_cons	-0.371	0.185	-2.01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

Table 4: Parameters of simulation

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

Graphs

Figure 1: TFP-FDI scatterplot³



³ Data source - BNB (2014), authors' calculations

Figure 2: Application of the model: simulation with γ_1

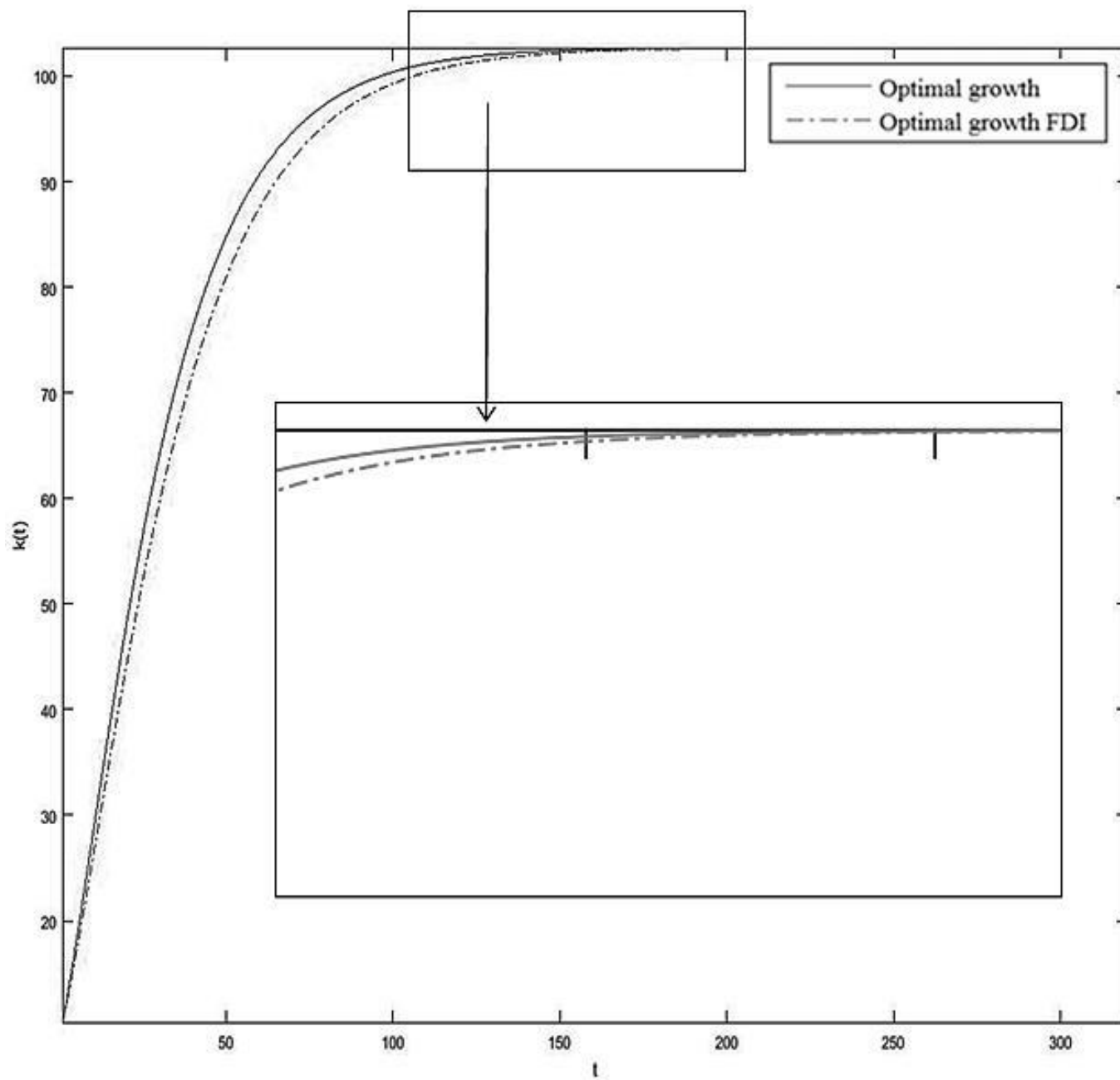


Figure 3: Application of the model: simulation with γ_2

