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RECENT DEVELOPMENTS IN THE GERMAN PHOTOVOLTAIC SECTOR

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Abstract

Purpose – The world is undergoing a dramatic shift in climate conditions. A heated debate is on-going over what measures to take in order to overcome the global-warming-related temperature increase, now more than 2 degrees centrigrade. The article tries to evaluate the contribution of the feed-in tariff (FIT) and the price of components for solar plants to the accumulation of new solar capacities in Germany, with the aim of determining the reasons for a drastic decline in the new capacities, observed since 2012.
Methodology – An autoregressive integrated moving average (ARIMA) is used with the new PV Capacities as a dependent variable and component prices and feed-in-tariffs as independent variables. Data from German Federal Network Agency is used.
Findings – The statistical analysis shows a significant effect of component prices (in EUR per watt) and the value of the FIT (in EUR) on the New PV Capacities. As Germany has not reached the postulated yearly increase rate of New PV Capacities of 2500 MW since 2014 (EEG, 2017), new approaches are necessary to overcome this situation.

Keywords: renewable energy, solar plants, energy tariffs

JEL classification: H23, H44, C5

Introduction

The world is undergoing a dramatic shift in climate conditions (Met Office 2015). As we could observe at the world climate conference in Paris 2015, most of the governments confirmed these severe problems. Nevertheless, what are the necessary steps to overcome the global-warming-related jump in temperature exceeding two-degrees centigrade is a topic of heated debates. But, as we can observe now, also big carbon dioxide polluters such as China or the United States of America seem to recognise the necessity to act (The White House 2015).

Especially Germany has started to act as a role model when it comes to the transformation of power supply, which has accelerated since the accident in Fukushima. Faster than formerly resolved, nuclear power plants will be shut down (Altmaier, 2013). In the year 2022 the last nuclear power plant in Germany will be closed (Altmaier, 2013). Therefore, Germany is in a transition phase towards renewable energy.

An important component of the German energy mix is solar plants (Frauenhofer, 2017). Since 2000, renewable energy has been subsidised, experiencing a heavy boom in Germany in recent years (especially during the years 2010-2012). Thus, the costs of trading in energy increased, forcing politicians to abandon the guaranteed feed in tariffs (FIT) for solar plants (Frauenhofer ISE 2017). Hence, investments have plummeted in recent years (see statista 2017).

The aim of the article is to evaluate the impact of the feed-in tariff (FIT) and the price of components for solar plants on the accumulation of New Solar Capacities in Germany in order to understand the drastic decline in new capacities since 2012.

1. Decreasing new capacities in Solar plans in Germany

Renewable energy plays a major role in the security of electrical power supply in Germany. In 2017, renewable energy accounts for ca. 33% of gross electricity production in Germany (see Figure 1). This share needs to be increased quickly to compensate not only for the soon-to-be closed nuclear plants, but also for coal-fired power stations which have to be shut down during the next decades to fulfil the government target of reducing the greenhouse gas emissions in Germany by 80% in 2050 compared to 1990 (Altmaier, 2013).

To ensure initial funding for renewable energy, which in the 2000s was not competitive compared to fossil fuels, the former government of left-wing democrats (SPD) and greens (Bündnis 90 die Grünen) introduced the Renewable Energy Law (EEG) in the year 2000 (BGBI, 2000). The key instruments to promote renewable energy were the obligation of the grid operator to connect renewable energy plants with the grid, a 20-year purchase guarantee and the feed-in-tariff (FIT), which means that the producer of renewable energy receives a fixed feed-in-tariff for the duration of 20 years.

Since then, the EEG has been amended several times to reflect the changing market realities.

As Figure 1 shows, the EEG has had a huge impact on the development of renewable energies between the years 2000 and 2017.

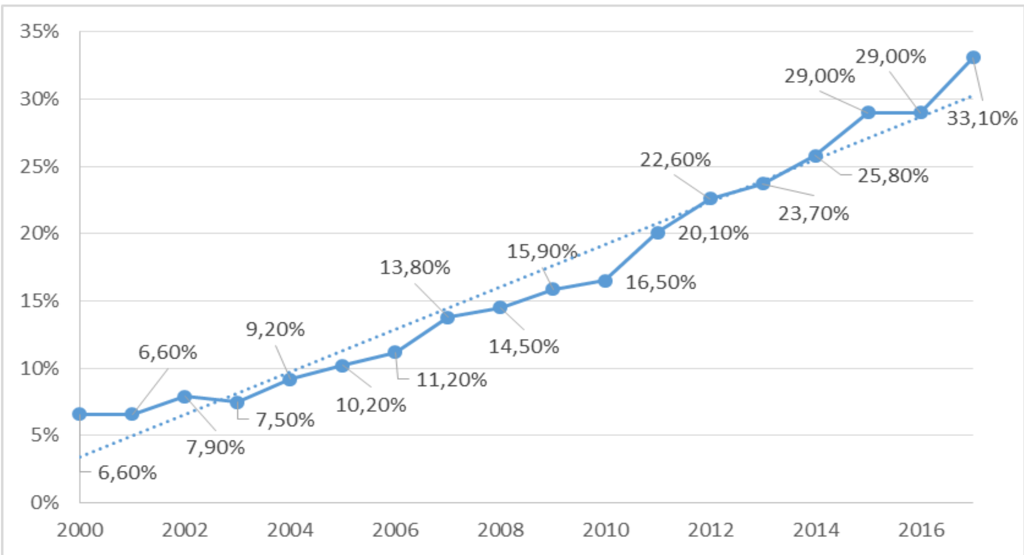

Figure 1. Share of renewables in gross electrical power output

Source: statista, available under https://de.statista.com/statistik/daten/studie/1807/umfrage/ erneuerbare-energien-anteil-der-energiebereitstellung-seit-1991/

Especially since 2010 energy sales in Germany have increased sharply.
Taking a look on the accumulating capacity of solar plants during these years, we see a booming photovoltaic industry in Germany during 2010-2012 (see Figure 2). The blue line in Figure 2 pictures the total New PV Capacities during 2009 and 2017, whereas the orange line shows the New PV Capacities which are subsidised according to the German renewable energy law (EEG). From 2015, these two lines start to diverge. The reason lies in the renewed EEG 2014 (BGB, 2014). According to this law, huge stand-alone solar plants are not subsidised anymore but are compensated at the rate offered by the lowest bidder in a tender organized by the federal grid agency. Thus, the blue line shows the total New PV Capacities per year and the orange line those still benefiting from fixed tariffs under the EEG.

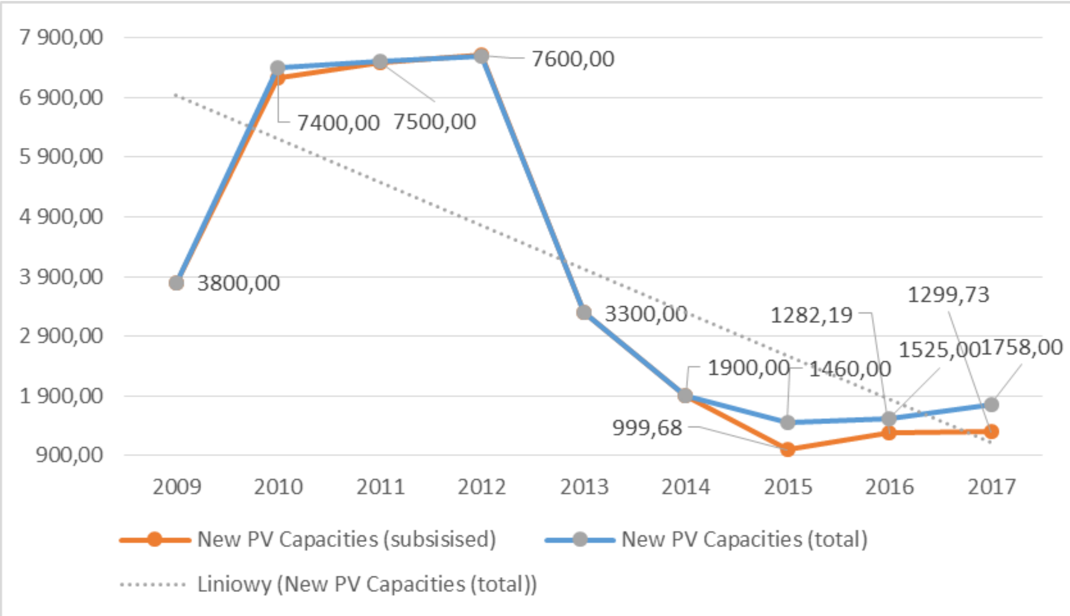

Figure 2. New PV Capacities subsidised and total

Source: Bundesnetzagentur (Federal Network Agency), available under https://www.bundesnetzagentur.de /DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/EEG_Registerdaten/ArchivDatenMeldgn/ArchivDatenMeldgn_node.html

From 2012 to 2013 a sharp decline in New PV Capacities occurred as a consequence of diminishing remuneration rates (FIT) (see Figure 3).

The rates were adjusted due to sky-rocketing costs for the energy transition in Germany (Dice consult, 2016). In Germany, every consumer of electricity has to pay a tax on every kWh consumed. This tax has risen sharply since 2000 and has pushed the price of kWh in Germany to the highest level in Europe (see Figure 4). Thus, politicians were forced to take action and on one hand lower the FIT in several steps and on the other integrate renewable energy into the regular electricity market.

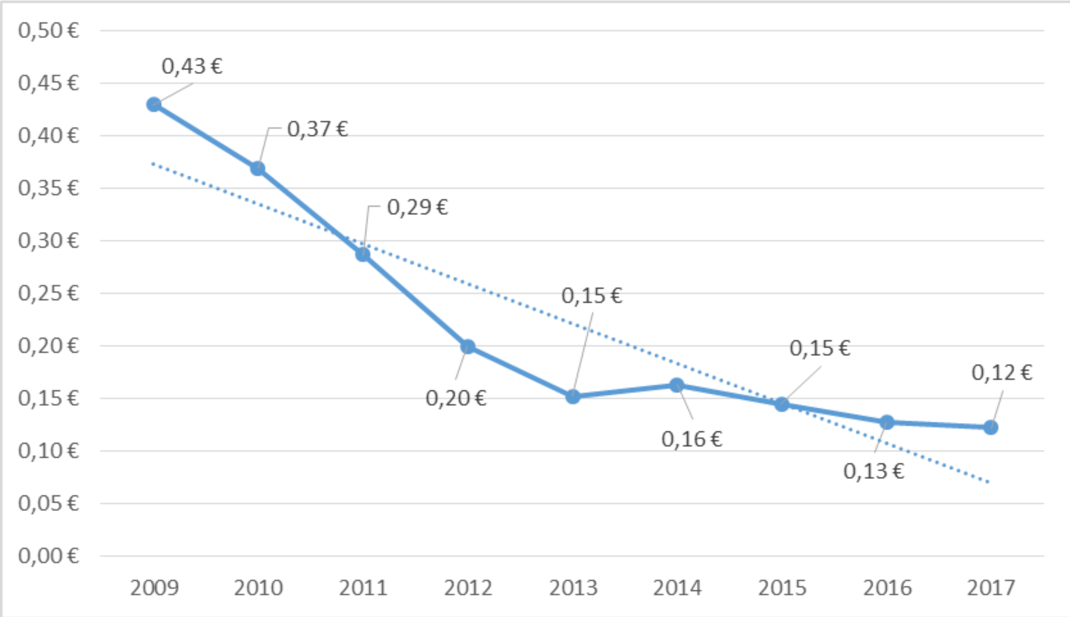

Figure 3. Feed-in-tariffs (FIT)

Source: Bundesnetzagentur (Federal Network Agency), available under https://www.bundesnetzagentur.de/DE/Sachgebiete/ElektrizitaetundGas/Unternehmen_Institutionen/ErneuerbareEnergien/ZahlenDatenInformationen/EEG_Registerdaten/ArchivDatenMeldgn/ArchivDatenMeldgn_node.html

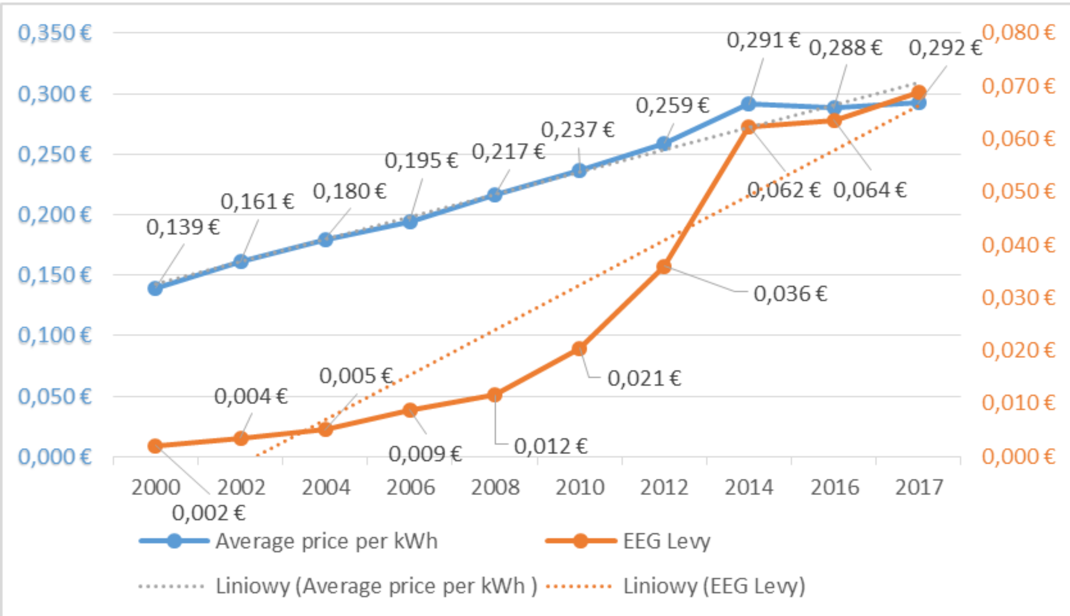

Figure 4. Rate of EEG Tax and average price per kWh in Germany

Source: Bundesverband der Energie- und Wasserwirtschaft, available under https://www.bdew.de/energie/strom-und-gaspreisanalysen-januar-2018/

Since the EEG amendment in 2012 (BGB, 2017), the EEG comprises aopportunity to produce electricity from solar plants which should be reach a certain output in every year. This output was between 2500 MW and 3500 MW per year (EEG, 2017) and is now 2500 MW per year (EEG 2017). Since 2014 the actual added capacity per year has fallen below this target level.

Beside the FIT, another factor contributing to the sharp increase of solar plants in Germany was represented by the declining prices of component (modules, inverters, etc.) needed to set up solar plants. Following investments in R&D, the prices to set up solar plants have dropped significantly in recent years. Figure 3 shows the developments in component prices in the USA from 2009 to 2017. Within 8 years the price per watt dropped from EUR 5.94 in 2009 to EUR 2.11 in 2017 (NREL, 2017).

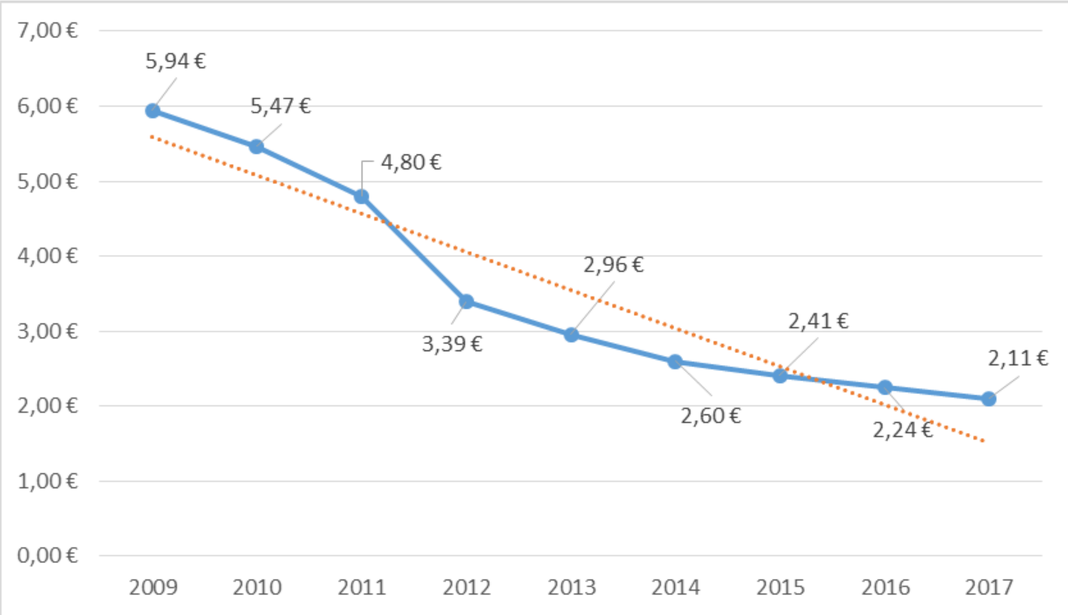

Figure 5. Component prices in the USA

Source: National Renewable Energy Laboratory, https://www.nrel.gov/docs/fy17osti/68925.pdf

To understand why the years 2010-2012 show average adding capacities in renewable energy, the next part of the paper is intended to analyse the dependency of the New PV Capacities on the variables Feed-In Tariff (FIT) and on component prices.

2. Capacity Growth Model

Three variables have been chosen for the analysis: new PV capacities as a dependent variable, component prices (in EUR per Watt) and FIT (in EUR). The data has the form of a time series with yearly intervals (from 2000 to 2007). The ARIMA model has been chosen and the necessary tests have been performed to verify the appropriate form of the model. First, the stationarity of the New PV Capacities is verified.

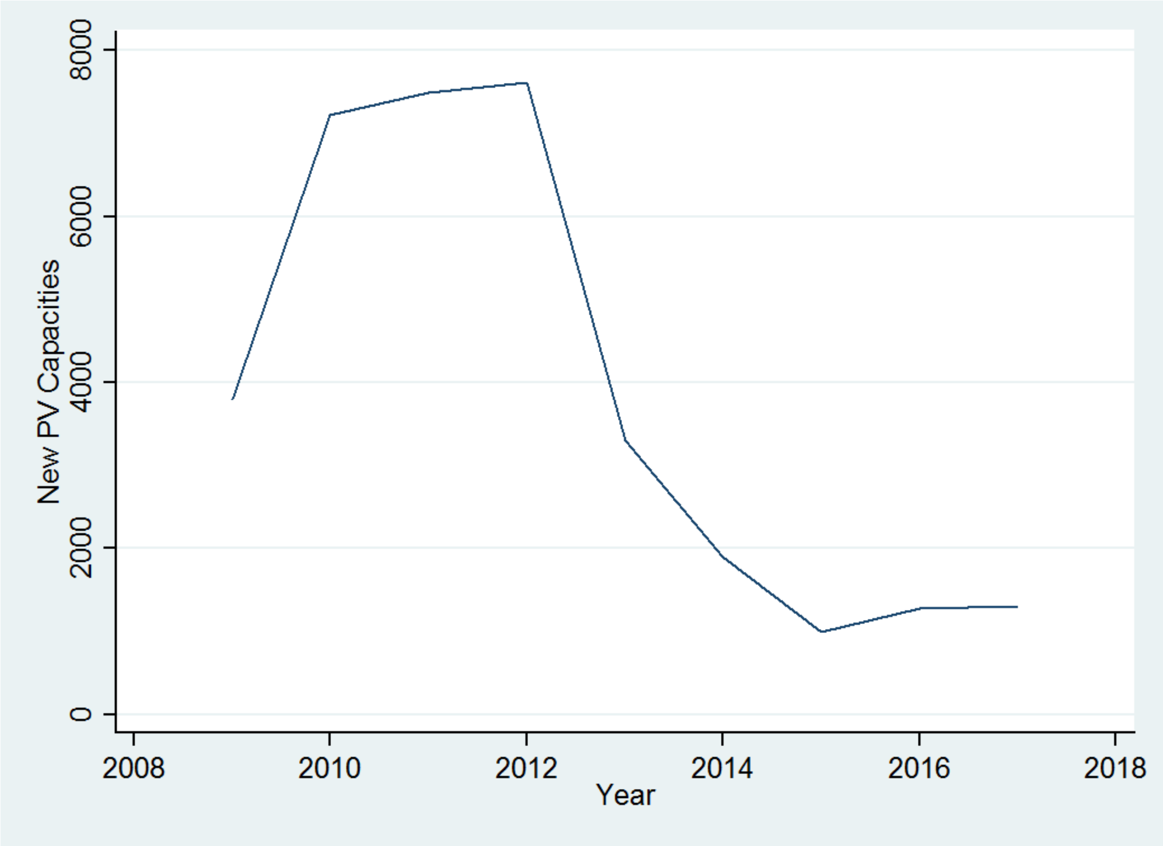

Figure 6. Stationarity of the new PV capacities

Source: The author's own calculation

The graph shows that the new PV capacities show a possibly non-stationary character. This can be further verified by applying the Augmented Dickey Fuller unit-root test. There is no visible trend, therefore the trend term is not included in the regression.

Table 1: Dickey-Fuller test for unit root

Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) = - 0.745	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.8349		Number of obs = 8	

Source: The author's own calculations

The results indicate that the null hypothesis that the time series data is non-stationary, cannot be rejected. And since the time series of PV capacities is non-stationary, further analysis cannot be performed.

Therefore, a new variable has been created – pv_d1 – first-order differentiation of time-series variable PV Capacities. The new variable is further verified for stationarity with a plot line and the Augmented Dickey Fuller test.

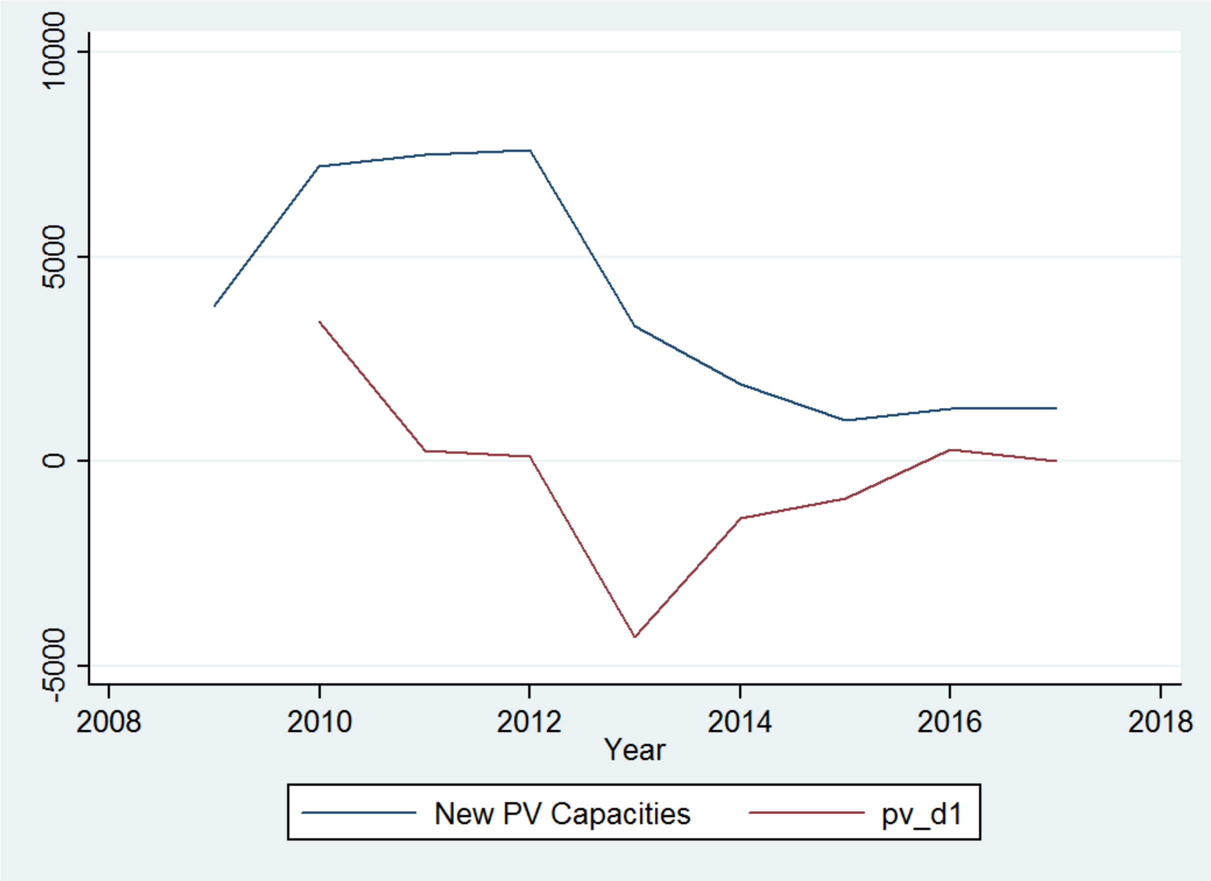

Figure 7. Stationarity of the New PV Capacities (first order differencing)

Source: The author's own calculation

Table 2: Dickey-Fuller test for unit root – first order differencing

Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t) = - 2.682	-3.750	-3.000	-2.630
MacKinnon approximate p-value for Z(t) = 0.0773		Number of obs = 7	

Source: The author's own calculation

The results are better and they show that at a significance level of 0.1 the hypothesis of non-stationarity can be rejected, thus allowing for further analysis.

A correlogram for the dependent variable has been created to extract the autocorrelation in the time series. If there is a presence of auto-correlation then moving averages are applicable for further analysis.

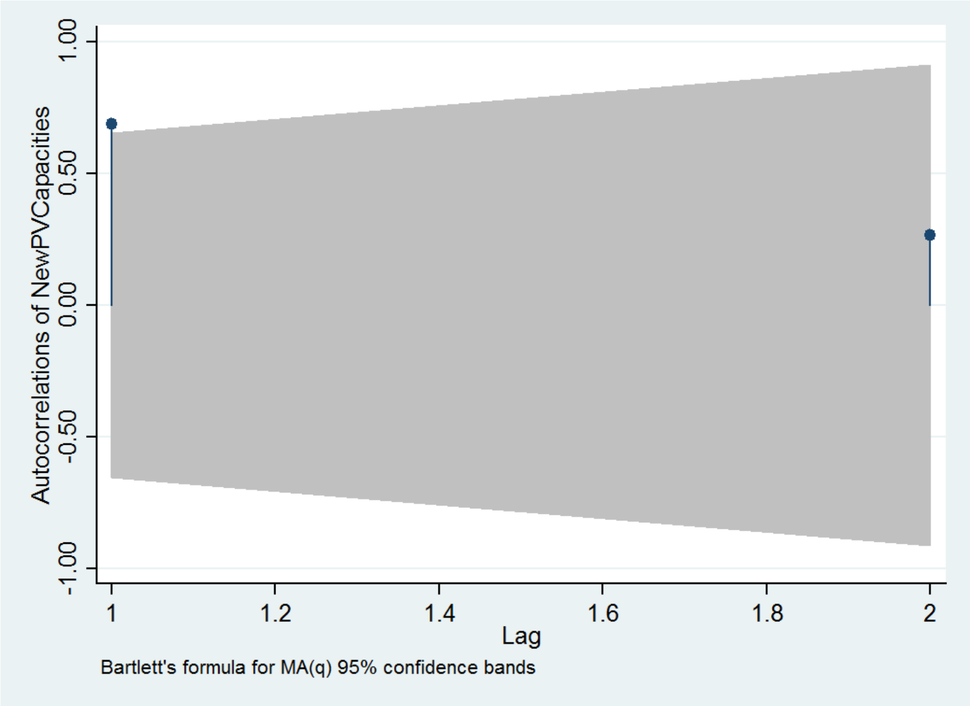

Figure 8. Correlogram for the dependent variable

Source: The author's own calculation

The correlogram shows that the first lag is beyond the acceptance region thus there should be a moving average of one in the further model.

Next, a partial correlogram for the dependent variable has been created to verify the presence of partial auto-correlation and thus the need for the inclusion of AR in further analysis.

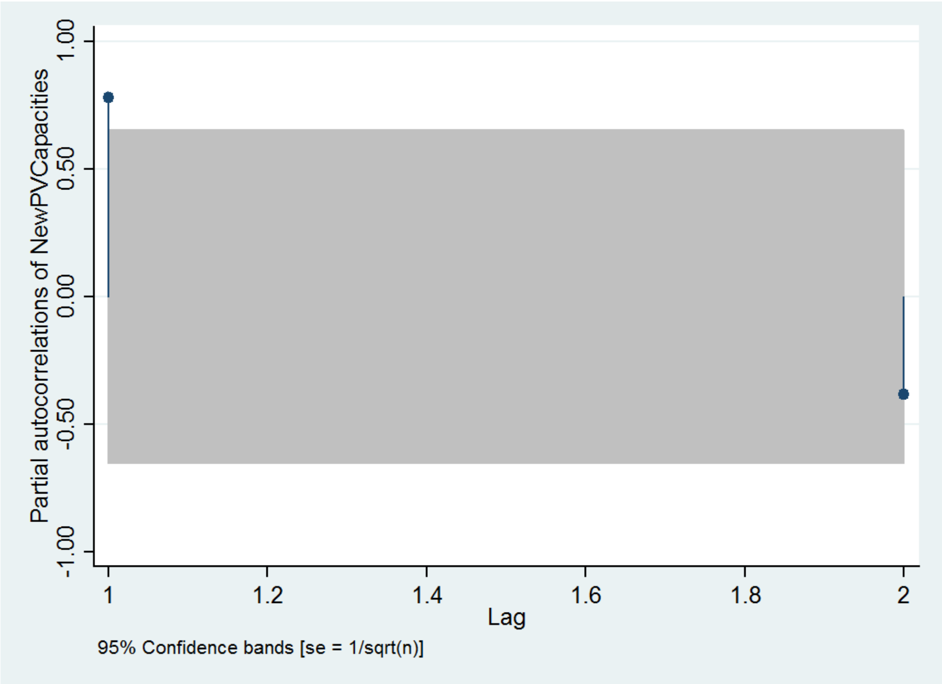

Figure 9. Partial correlogram for the dependent variable

Source: The author's own calculations

The partial correlogram shows a partial auto-correlation of the first degree. Thus, the analysed model will therefore include an AR of 1.

Based on the results of the Dickey-Fuller test and the correlograms, and ARIMA model with the parameters of I=1, AR=1, MA=1 is calculated.

Table 3: ARIMA model for New PV Capacities (1,1,1)

D.NewPVCapacities	Coef.	OPG Std. Err.	z	P>z	[95% Conf.	Interval]
NewPVCapacities						
ComponentpricesEURperWatt D1.	10033.19	1849.278	5.43	0.000	6408.675	13657.71
FITEUR D1.	-112612.6	18083.79	-6.23	0.000	-148056.2	-77169.03
_cons	28.9641	528.0976	0.05	0.956	-1006.088	1064.016
ARMA						
ar L1.	-.7693555	.2298859	-3.35	0.001	-1.219924	-.3187875
ma L1.	-.9999985	1.044039	-0.96	0.338	-3.046277	1.04628
/sigma	829.0011	.	.	.	.	.
Sample: 2010 – 2017; Number of obs = 8; Wald chi2(4) = 104.02; Log likelihood = -67.17744; Prob > chi2 = 0.0000						

Source: The author's own calculation

The model is formally sound, however the moving average is not statistically significant. Thus, another model, without the moving average has been calculated.

Table 4: ARIMA model for New PV Capacities (1,1,0)

D.NewPVCapacities	Coef.	OPG Std. Err.	z	P>z	[95% Conf.	Interval]
NewPVCapacities						
ComponentpricesEURperWatt D1.	8137.038	4168.659	1.95	0.051	-33.38271	16307.46
FITEUR D1.	-94428.28	46354.17	-2.04	0.042	-185280.8	-3575.767
_cons	-185.9441	848.2335	-0.22	0.826	-1848.451	1476.563
ARMA						
ar L1.	-.7996709	.2421705	-3.30	0.001	-1.274316	-.3250253
/sigma	1374.439	859.0169	1.60	0.055	0	3058.081
Sample: 2010 – 2017; Number of obs = 8; Wald chi2(4) = 11.29; Log likelihood = -69.67198; Prob > chi2 = 0.0103						

Source: The author's own calculation

The final model shows that the New PV Capacities are statistically significantly affected by the component prices (in EUR per Watt) and by the value of FIT (in EUR). Also, there is a statistically significant negative component of L1 meaning that the value of new PV capacities in a given period negatively affects the value of new PV capacities in the following period. The model is formally correct, as proven by the p-value for the chi2 test.

Conclusion

The statistical analysis shows a significant effect by the component prices (in EUR per watt) and the value of the FIT (in EUR) on the new PV capacities. As Germany has not reached the postulated yearly adding of New PV Capacities of 2500 MW since 2014 (EEG, 2017), new approaches are necessary to overcome this situation.

In recent years, the German government has started to integrate the renewable energy into the regular electricity market, thereby exposing the renewable energy to the market forces. Solar plants >750 kW are only allowed to be launched in the case of a successful participation in a call for bids. There are three per year with a total of 600 MW (EEG, 2107). This has helped to decrease the average price to 5.01 per kWh (Bundesnetzagentur, 2018) cent per kWh but has led to a massive decrease of the yearly new PV capacities. Considering that in 2017 only 25.9% of the owners of photovoltaic plants were institutional investors such as funds etc. (which are normally investors in huge stand-alone solar plants >750 kWh), this means that there is also a massive drop in new investments from private persons, farmers and industry representing nearly 75% of the ownership in 2017 (Agentur für Erneuerbare Energien, 2018) and still subsidised under the EEG (just invested in new capacities in 2017 of ca. 1300 MW). These non-institutional investors still depend on the FIT as they lack the opportunities like institutional investors have when it comes to sourcing etc.

To strengthen the investments of private persons the legislator introduced the so-called “PV-Mieterstromanlagen” in 2018. This means that also private persons who do not own a house where rooftop solar systems could be installed can run a solar system if they live for rent. This is interesting in Germany where more and more people live for rent in urban areas (see United Nations (UN) 2018). But from January to August 2018 just small success could be attested (3.826 kWp) (Bundesnetzagentur, 2018).

The other independent variable, the Component prices are predicted to decrease also in the years coming without interference of the German government (Agora Energiewende, 2015). Thus, the German government just needs to adjust the income side of investors to stimulate necessary investments to keep on track.

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