

The Fairy Tale of Unicorns

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Abstract: Unicorns have become symbols of entrepreneurial success and innovation-friendly countries. Therefore, understanding the process of diffusion of these highly valued startups has important implications for business, investors and policymakers. However, the existing literature lacks a description of the diffusion and forecast of these types of ventures. We address this gap by analyzing the diffusion process of unicorns in 8 countries (USA, China, India, UK, Germany, France, Netherlands, and Sweden) and 3 industries (Fintech, Health, and Transportation) using both 3-parameters and 4-parameters Gompertz and Logistic models. Our diffusion analyses reveal that the Gompertz model is suited for analyzing unicorn diffusion in China, whereas the Logistic model is appropriate for analyzing unicorn diffusion in the rest of the countries studied. We also find that India has the highest estimated speed of diffusion (97%) while the USA has the highest saturation level of unicorns (6241). Our forecasting analyses indicate that all the countries selected in our study, except the USA, will achieve their saturation level of unicorn diffusion in five to seven years. Further, results regarding unicorn diffusion by sectors show that the Logistic model is suited for analyzing unicorn diffusion in all the sectors studied. Results of forecasting analyses indicate that the Fintech sector needs twice the period required for the Transportation and Health sectors to achieve the maximum level of unicorn diffusion. These findings are useful for planning, regulation, policy formulation, and portfolio decision.

Keywords: Startup, Unicorn, Diffusion, Forecasting, Logistic Model, Gompertz Model

1. Introduction

Over the last decade, the term "unicorn startup" which is one particular type of entrepreneurial phenomenon has captured significant popularity. Broadly defined, unicorns are privately held startups with a market capitalization of more than \$1 billion. The term "unicorn" refers to the rarity of start-ups that achieve this status among the population of startups. Just ten years ago, when they were first coined by venture capitalist Aileen Lee, only 38 unicorns existed. As of the beginning of 2023, there are over 2600 unicorns around the world ([Dealroom.co](https://www.dealroom.co)). Despite their rising number, unicorns remain still quite rare. For example, in Europe, only 1 in 100 companies raising a seed round would reach the \$1 billion valuation (Atomico et al., 2020). Only a small number of startups become unicorns since they are dedicated to offering creative solutions and new business models, among other things, without any synergy with existing markets. This type of company provides products and services that have accomplished incredibly fast diffusion rates and business growth. Generally, in most cases, they are disrupting entire industries by replacing a process, or a product that is already well-established, giving rise to a new way to operate (Stadler, 2016).

In the last two years, the growth of unicorns has been phenomenal. Assisted by the growing internet penetration and enabled by digital technologies, it seems that innovation not only positively moderates the negative effect of the pandemic but accelerated the adoption of start-ups. In 2021, the number of unicorns around the world jumped from 315 one year before to 787 ([Dealroom.co](https://www.dealroom.co)), which means that on average two unicorns are created every day. It is this spectacular diffusion in a period of general recession that gives the history of unicorns this characteristic of a "fairy tale". Performing through the crisis seems sometimes impossible, but some unicorns have proven that this idea is just a myth. In general, achieving unicorn status takes several years (requires an average of at least five years) but some startups have achieved unicorn status so fast that it almost seems impossible. Some American (ClickHouse, Pacasso, Avant...), Chinese (iCarbonX...), or European (NuCom Group, Gorillas...) startups achieved unicorn status in just a few months, less than one year.

Schumpeter (1943) predicted well the role of innovation in economic growth via the process of creative destruction, however this exponential growth, in an embryonic phase, in terms of number or in terms of passage from startup position to unicorn position was not predicted. With the increasing number of unicorn startups, several studies have been conducted on the risks of unicorns (Fan, 2016; Govindarajan, 2016; Wu Jin, 2018), and their valuation (Gornall & Strebulaev, 2020; Jacobus, 2016); public and private initial public offering IPO investments into unicorns (Brown & Wiles, 2015; Kengelbach et al., 2018) performance and financial state

(Demartini, 2018; Gao et al., 2019; Laitinen, 2017); characteristics and growth environment of unicorns (Guo & Zhang, 2021); governmental decisions affecting unicorns (McNeill, 2016). To the best of our knowledge, the existing literature lacks a description of the diffusion and the forecast of these types of ventures. We address this gap by analyzing the diffusion process of unicorns in 8 countries (USA, China, India, UK, Germany, France, Netherlands, and Sweden) and 3 industries (Fintech, Health, and Transportation), using Logistic and Gompertz models both with three and four parameters.

While it has been claimed that focusing on unicorns could conduce to a biased picture of entrepreneurship (Kuckertz et al.2023), several studies show that startup companies and especially unicorns have become the basic drivers of innovation and can contribute significantly to both job and wealth creation (e.g., Guo and Zhang, 2021; Testa et al., 2022). For that reason, economic development policy should support unicorn emergence and growth. From this economic viewpoint, an appropriate prediction of the unicorn diffusion can enable the policymakers “to act at the right time” to make suitable decisions. The derived knowledge can be used by policy makers and regulators for the development strategy of unicorn growth. Besides, investing in such new businesses (with high growth potential) seems rational. Many venture capitalists only consider investing in startups that have the potential to become unicorns. Accordingly, long run forecasts of unicorn diffusion should also guide investors in their portfolio decisions.

The contribution of this study lies in its analysis of the process of diffusion of unicorns using growth diffusion models. The scant existing literature looking at this question suggests that the diffusion process of this type of venture can't be supported by growth models of diffusion due to the incredibly high speed at which they diffuse into the market (Urbinati et al., 2018; Trabucchi, Talenti, and Buganza, 2019). For example, Urbinati et al. (2018) argue that the diffusion process of unicorns should rather be explained by their business model design, using the historical data of 50 unicorns. However, it's well known that the most disruptive innovations are the car and television. Meade and Islam (2015) reported: "Our preliminary literature search found that studies focusing on hardware (television, cellular phones, computer and network equipment) predominated. Hence, contrary to previous studies on unicorn diffusion, we show that growth models of diffusion work well and could be considered as highly performing tools, to describe and forecast the evolution of unicorns.

The paper is organized as follows. The next section provides a theoretical overview of the growth models of diffusion that were used to empirically explore the research questions. The third section describes methodology and data. In section four, we summarize and discuss the results obtained from our analyses. Finally, section five concludes pointing out the practical implications arising from our study and giving some avenues for future research.

2. Growth models of diffusion

Many mathematical representations of the sigmoid shape are used in the literature on diffusion models. But, the Gompertz and Logistic models are the most frequently used sigmoid models fitted to growth data. Both curves of these models share the interesting property that their “S-shaped” feature is suitable to describe processes that began with a slow rate in the first stage of adoption, followed by a stage of rapid adoption which then tails off as the adopting population becomes saturated. Recently, it has been found that the results of these growth models with four parameters are more consistent than those provided by the Gompertz and Logistic models with three parameters (Akin et al., 2020; Satoh, 2021). Thus, we consider the growth models with four parameters in addition to these classical models. The accuracy of the goodness of fit of the estimation model is evaluated by Root Mean Square Error (RMSE) and adjusted R2. The accuracy of forecasting is evaluated by the aggregate error - Mean absolute percentage error- MAPE and- mean absolute error- MAE. As Jha & Saha (2020) and Akin et al. (2020), we use the following representation for each model.

2.1 Logistic model

The logistic curve is symmetric with respect to its inflection point. The Logistic model with three parameters (LM3P) is :

$$U(t) = \frac{M}{1 + e^{-\alpha(t-\beta)}} \quad (1)$$

M , β , and α are all positive parameters.

M is the market potential or the maximum number of possible unicorns, α is the growth rate or pace of adoption of the unicorns and β is the inflection point indicating the point in time at which the growth of the adoption of unicorns reaches its peak and starts decreasing. This is produced when the diffusion of unicorns achieved half of its maximum level ($\frac{M}{2}$). The Logistic model with four parameters (LM4P) is :

$$U(t) = A + \frac{B}{1 + e^{-\alpha(t-\beta)}} \quad (2)$$

Where A is a location parameter and acts as the lower asymptote, B is the asymptotic amount of growth of unicorns that occurs as t increases, and $A+B=M$.

2.2 Gompertz model

The Gompertz curve has the property of being asymmetrical about the inflection point. The Gompertz model with three parameters (GM3P) is :

$$U(t) = Me^{-e^{-\alpha(t-\beta)}} \quad (3)$$

M is the market potential or the maximum number of possible unicorns, α is the growth rate or pace of adoption of the unicorns and β is the inflection point indicating the point in time at which the growth of the adoption of unicorns reaches its peak and starts decreasing. This is produced when the diffusion of unicorns achieved the share $1/e \approx 36.8\%$ of its maximum level ($\frac{M}{e}$). The Gompertz model with four parameters (GM4P) is:

$$U(t) = C + De^{-e^{-\alpha(t-\beta)}} \quad (4)$$

Where C is a location parameter and acts as the lower asymptote, D is the asymptotic amount of growth of unicorns that occurs as t increases and $C+D=M$.

3. Methodology and data

3.1 Methodology

Our research methodology consists of two main stages. In the first stage, we estimate the diffusion model parameters specified in equations (1), (2), (3) and (4) for each country and each industry of our sample, using a nonlinear least squares (NLS) regression. We then choose the model with the maximum adjusted R^2 and the least RMSE as the best-fit model for the given historical data. In the second stage, we forecast the diffusion of unicorns by country and industry during the years 2023-2033. The forecasting performance of each model is tested using two main indicators, namely the Mean Absolute Deviation (MAD) and the Mean Absolute Percentage Error (MAPE). We choose the model that gives the smallest MAPE and MAE.

3.2 Data

We use time series data on cumulative unicorns from the Dealroom database and more specifically the so-called "Unicorn Club". Several previous studies are based on this database such as Burstrom et al. (2023) and Testa et al. (2022). The Unicorn Club is particularly well-adapted for research as it is updated on a daily basis and is structured in an accessible way (Retterath and Braun, 2020). It provides detailed data on the number of new and cumulative unicorns by continents, countries, and industries since 2000. According to this database ([Dealroom.co](https://www.dealroom.co)), there are currently 2615 unicorn companies worldwide, 90% of them predominantly located in just 15 countries. Among these countries, the USA and China alone account for 54% and 12.42% of the total number of unicorns, respectively. The most represented industries are fintech with 517 companies in this category, health with 433 unicorns, and transportation with 234 unicorns. The dataset used for this paper was downloaded in December 2022. It covers the period 2000-2022 and contains information on the number of cumulative unicorns in 8 countries (USA, China, India, UK, Germany, Sweden, France, and the Netherlands) and 3 industries (Fintech, Health, and Transportation). Our database represents 80% of the worldwide unicorns.

4. Results and discussions

We use the NLS regression and STATA 15 software to estimate the parameters in (1), (2), (3), and (4), after providing suitably chosen starting values, as the two curves are non-linear in the parameters of interest. The estimated parameters are then used to obtain forecasts of the variable U . The quality of the fit to the data is excellent for each model. All models indicate high accuracy with the Adjusted determination coefficient (Adj_R^2) of more than 95%. All the parameters of the models are almost statistically significant at the 1% level. In the following sections, we detail our results by country and by sector.

4.1 Unicorn diffusion and forecasting by countries

The results of the analysis, for the eight countries, are summarized in Table 1. The models obtained for all countries in the study are statistically significant and all the parameters of the models are statistically significant at a 1% level, except for the saturation point parameter in the case of the USA, UK, and Germany (Table 1). We can infer from Table 1 that the Logistic model is suited for analyzing unicorn diffusion in the USA, India, Germany, the UK, France, Netherlands, and Sweden. This model yields a lower RMSE and higher adjusted R^2 than the Gompertz model. Whereas, in the case of China, the Gompertz model is more suitable to describe unicorn diffusion. Our results of the Logistic model for the unicorn diffusion in the USA indicate a maximum level of 6241.574. The speed of convergence to the saturation level is 0.322 and half of its maximum level will be achieved in 2026. Using the logistic model with four parameters, we find almost the same results as those reported above. The results of the Gompertz model indicate an overestimation of the potential maximum number of unicorns and a very low speed of diffusion (0.017). Values of adjusted R^2 , RMSE, MAE, and MAPE indicate that the Logistic model with three parameters is the best in describing and forecasting the unicorn diffusion in the USA. Our forecasting analysis shows that the saturation of unicorn diffusion in the USA, generated by the Logistic model, is predicted to be achieved in 2052. The results of the Logistic model for the diffusion of unicorns in China indicate a maximum level of 335.796 and the speed of convergence to the saturation level is 0.694. Unicorn diffusion has achieved half of its maximum level in 2018. The results of the Gompertz model indicate a maximum diffusion level of 380.713, the speed of diffusion is 0.378, and 36.8% of its maximum level is achieved in 2017. Based on the values of adjusted R^2 , RMSE, MAE, and MAPE, we find that the Gompertz model with three parameters has the best performance both in describing and forecasting the unicorn diffusion in China. Our forecasting analysis shows that the saturation of unicorn diffusion in China, generated by the Gompertz model, is predicted to be achieved in 2032.

As for the UK, our results of the Logistic model with three parameters for the unicorn diffusion reveal a maximum level of 545.113 (but not statistically significant). The speed of convergence to the saturation level is 24.5% (significant at 1%) and half of its maximum level will be achieved in 2027. Using the Gompertz model, we find similar results as in the case of the USA. The potential maximum number of unicorns is also overestimated, while the speed of diffusion is underestimated. Values of adjusted R^2 , RMSE, MAE, and MAPE indicate that the Logistic model is the best in describing and forecasting the unicorn diffusion in the UK. Our forecasting analysis shows that the saturation of unicorn diffusion in the UK, generated by the Logistic model, is predicted to be achieved after 2032. With regard to India, the results of the Logistic model with four parameters for the diffusion of unicorns indicate a maximum level of 139.889, and the speed of convergence to the saturation level is 97%. Unicorn diffusion has achieved half of its maximum level in 2021. The results of the Gompertz model indicate a maximum diffusion level of 313.211 (but not statistically significant), the speed of diffusion is 0.298, and 36.8% of its maximum level is achieved in 2022. We can infer from Table 1 that the Logistic model with four parameters provides more accurate results in describing and forecasting the unicorn diffusion in India, as reflected in its high adjusted R^2 , low RMSE, MAE, and MAPE. Our forecasting analysis shows that the saturation of unicorn diffusion in India, generated by the Logistic model, is predicted to be achieved in 2030.

The results of the Logistic model, with four parameters, for the diffusion of unicorns in France show a maximum level of 91.9, and the speed of convergence to the saturation level is 0.496. Unicorn diffusion has achieved half of its maximum level in 2023. The Gompertz model highly overestimates the ultimate potential number of unicorns and underestimates the speed of diffusion. The Logistic model, with four parameters, is found appropriate to describe the process of unicorn diffusion in France, whereas the Gompertz model is the best to predict the diffusion of unicorns. However, considering that the forecasting performance of the Logistic and Gompertz models do not differ significantly, and since the ultimate market potential estimate of the Logistic model is more realistic (91.9), we choose the Logistic model over the Gompertz model to forecast the unicorn diffusion in France. According to our forecasting results, generated by the Logistic model, the saturation of

unicorn diffusion in France will be achieved in 2032. The Logistic model, with four parameters, also performs well in describing and forecasting the diffusion process in Sweden and Netherlands. In Sweden, the maximum potential number of unicorns is 48, and half of this number is attained in 2021. However, it took a year later for the Netherlands to achieve half of its ultimate potential number of unicorns which is 57. Our results also show that unicorns in Sweden are diffusing at 2.4 times the speed of unicorn diffusion in the Netherlands. Regarding our forecasting results, we find that while Sweden will achieve its saturation point of unicorn diffusion in 2027, the Netherlands needs five years more to achieve its maximum potential number of unicorns.

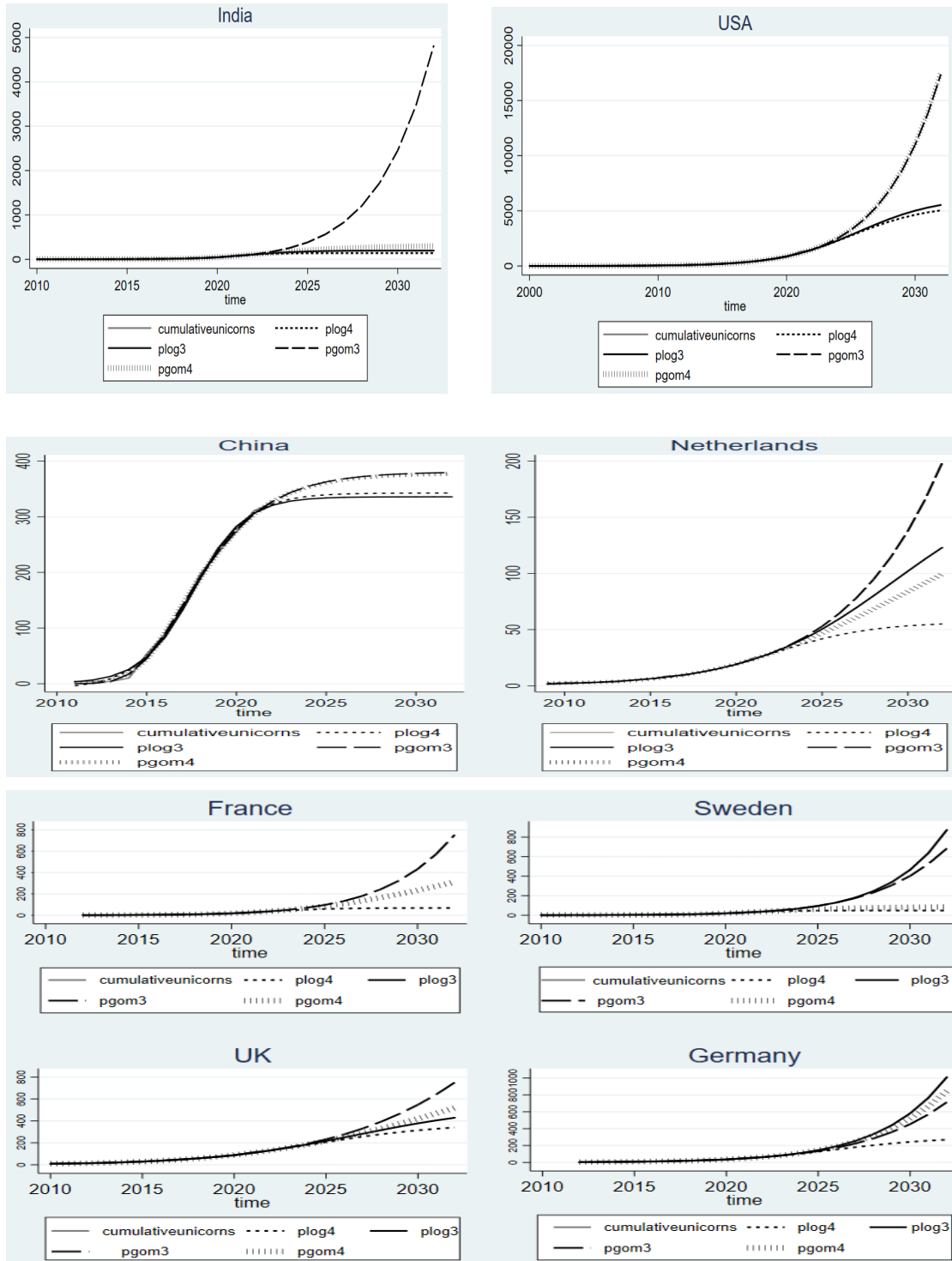


Figure 1: Diffusion and forecasting of unicorns by countries; plog4= forecasting by LM4P, plog3 = forecasting by LM3P, pgom3= forecasting by GM3P, pgom4 = forecasting by GM4P.

Table 1: Estimated parameters of the unicorn diffusion models by countries

Significance level: *, $p < 1\%$; **, $p < 5\%$; ***, $p < 10\%$. Some values are not reported since the modeling failed to achieve the convergence criteria even after thousands of iterations.

Parameters	USA (n=23)		China (n=12)		UK (n=13)		India (n=13)	
	Logistic	Gompertz	Logistic	Gompertz	Logistic	Gompertz	Logistic	Gompertz
M_3P	6241.574	8.94e+09	335.796 *	380.713*	545.113	452195.2	196.359*	6.94e+08
M_4P	5 545,489	-	342,582*	378,268*	381.833	2 358,319	139.889*	313.211
α _3P	0.322 *	0.017*	0.694*	0.378*	0.245*	0.024	0.678*	0.028*
α _4P	0.331*	-	0.637*	0.385*	0.276**	0.066	0.97*	0.298**
β _3P	2025.629*	2182.154*	2017.603*	2016.996 *	2026.676*	2109.214*	2021.719*	2121.446*
β _4P	2025.065*	-	2017.574*	2017.007*	2024.435*	2038.416*	2020.835*	2022.305*
In-sample								
Adj R ² _3P	0.995	0.995	0.998	0.999	0.997	0.996	0.987	0.985
Adj R ² _4P	0.993	-	0.996	0.998	0.991	0.991	0.988	0.983
RMSE_3P	34.047	34.978	8.122	5.119	3.683	3.727	4.532	4.849
RMSE_4P	34.825	-	7.583	5.304	3.853	3.841	3.685	4.386
Out-of-sample								
MAE_3P	15.412	16.437	5.898	3.791	2.252	2.339	3.227	3.309
MAE_4P	15.685	-	5.194	3.6	2.181	2.151	2.37	2.745
MAPE_3P	0.132	0.135	0.415	0.238	0.063	0.068	0.465	0.373
MAPE_4P	0.417	-	0.467	0.19	0.055	0.052	0.451	0.483

Parameters	Germany (n=13)		France (n=13)		Sweden (n=13)		Netherlands (n=14)	
	Logistic	Gompertz	Logistic	Gompertz	Logistic	Gompertz	Logistic	Gompertz
M_3P	2648.196	3.59e+08	15139.13	4.64e+08	81455.96	1.82e+08	186.937	1.26e+08
M_4P	301,384	1.08e+08	91.9**	1.11e+08	48,308*	88,65***	56,765**	236,871
α _3P	0.285*	0.017*	0.355*	0.021*	0.319*	0.021*	0.236*	0.013*
α _4P	0.349	0.020*	0.496*	0.024*	0.834*	0.295**	0.347*	0.091***
β _3P	2035.042*	2182.009 *	2039.03*	2157.377*	2046.163	2153.066*	2029.22	2224.1 *
β _4P	2025.927 *	2154.355 *	2022.98*	2132.8*	2020.632*	2021.679*	2022.154*	2030.601*
In sample								
Adj R ² _3P	0.982	0.984	0.991	0.991	0.983	0.985	0.995	0.996
Adj R ² _4P	0.955	0.960	0.991	0.990	0.990	0.985	0.992	0.991
RMSE_3P	3.557	3.408	1.117	1.124	1.982	1.865	0.837	0.82
RMSE_4P	4.138	3.888	0.950	0.980	1.131	1.39	0.776	0.794
Out of sample								
MAE_3P	2.48	2.461	0.817	0.894	1.456	1.488	0.603	0.618
MAE_4P	2.59	2.594	0.546	0.572	0.729	0.937	0.523	0.541
MAPE_3P	0.4	0.344	0.338	0.399	0.246	0.306	0.108	0.112
MAPE_4P	0.235	0.226	0.143	0.123	0.260	0.301	0.084	0.086

For the case of Germany, performance analysis of non-linear growth models based on adjusted R^2 and RMSE shows that the Gompertz model with three parameters is more suited to describe and forecast the diffusion of Deutschland unicorns. However, the saturation value is highly overestimated while the growth rate is underestimated, and these values do not seem plausible with the data of Germany. This problem of estimation was also detected by several prior researchers such as Gamboa & Otero (2009) and Jha & Shah (2020) in the telecommunication industries. Further, we note that the NLS estimation procedure needs more than two thousand iterations to achieve the convergence criteria, while the Logistic model requires just a few iterations. Since the maximum potential number of unicorns estimated with the Logistic model is more realistic, we choose the Logistic model over the Gompertz model to describe and forecast the diffusion processes of unicorns in Germany. To choose between a Logistic model with three or four parameters, we refer to Figure 1. We find that the Logistic model with four parameters fits the real adoption curve the most closely. Therefore, we consider this model as the best one suited for describing and forecasting the Deutschland unicorn diffusion. The results show that the growth rate is 34.9%, the saturation level is 301.384, and half of this saturation level will be reached in 2026. According to our forecasting analysis results, generated by the Logistic model with four parameters, unicorn diffusion in Germany will achieve 128 in 2025.

4.2 Unicorn diffusion and forecasting by sectors

The models obtained for all sectors in the study are statistically significant and almost all the parameters of the models are statistically significant at 1% level. We can infer from Table 2 that the Logistic model is suited for analyzing unicorn diffusion in all three sectors as it yields a lower RMSE and a higher adjusted R^2 than the Gompertz model.

Our results of the Logistic model for the unicorn diffusion in the Fintech sector indicate a maximum level of 1630.231. The speed of convergence to the saturation level is 0.431 and half of its maximum level will be achieved in 2024. Using the logistic model with four parameters, we find almost the same results as those reported above. The results of the Gompertz model indicate an overestimation of the potential maximum number of unicorns and a very low speed of diffusion (0.022). Values of adjusted R^2 and RMSE indicate that the Logistic model with 3 parameters is found appropriate to describe the process of the unicorn diffusion in the Fintech sector, whereas the Gompertz model is the best to predict the diffusion of unicorns. However, considering that the forecasting performance of the Logistic and Gompertz models do not differ significantly, and, since the ultimate market potential estimate of the Logistic model is more realistic (1630.231), we choose the Logistic model with three parameters over the Gompertz model to forecast the unicorn diffusion in the Fintech sector. Our forecasting analysis shows that the saturation of unicorn diffusion in the Fintech sector, generated by the Logistic model with three parameters, is predicted to be achieved in 2040.

The results of the Logistic model with three parameters for the diffusion of unicorns in the health sector indicate a maximum level of 619.390 and the speed of convergence to the saturation level is 50.8%. Unicorn diffusion achieved half of its maximum level in 2020. The results of the Gompertz model indicate a maximum diffusion level of 1440.596, the speed of diffusion is 15.9% and 36,8% of its maximum level is achieved in 2023. Based on the values of adjusted R^2 , RMSE, MAE, and MAPE, we find that the Logistic model with three parameters has the best performance both in describing and forecasting the unicorn diffusion in the health sector. Our forecasting analysis shows that the saturation of unicorn diffusion in the health sector, generated by the Logistic model, is predicted to be achieved in 2030.

With regard to the Transportation sector, the results of the Logistic model with three parameters for the diffusion of unicorns indicate a maximum level of 318.955, and the speed of convergence to the saturation level is 50.4 %. Unicorn diffusion achieved half of its maximum level in 2020. The results of the Gompertz model indicate a maximum diffusion level of 615.22, the speed of diffusion is 17.6% and 36,8% of its maximum level is achieved in 2022. We can infer from Table 2 that the Logistic model with three parameters provides more accurate results in describing and forecasting the unicorn diffusion in the Transportation sector, as reflected in its high adjusted R^2 , low RMSE, MAE, and MAPE. Our forecasting analysis shows that the saturation of unicorn diffusion in the Transportation sector, generated by the Logistic model, is predicted to be achieved in 2030.

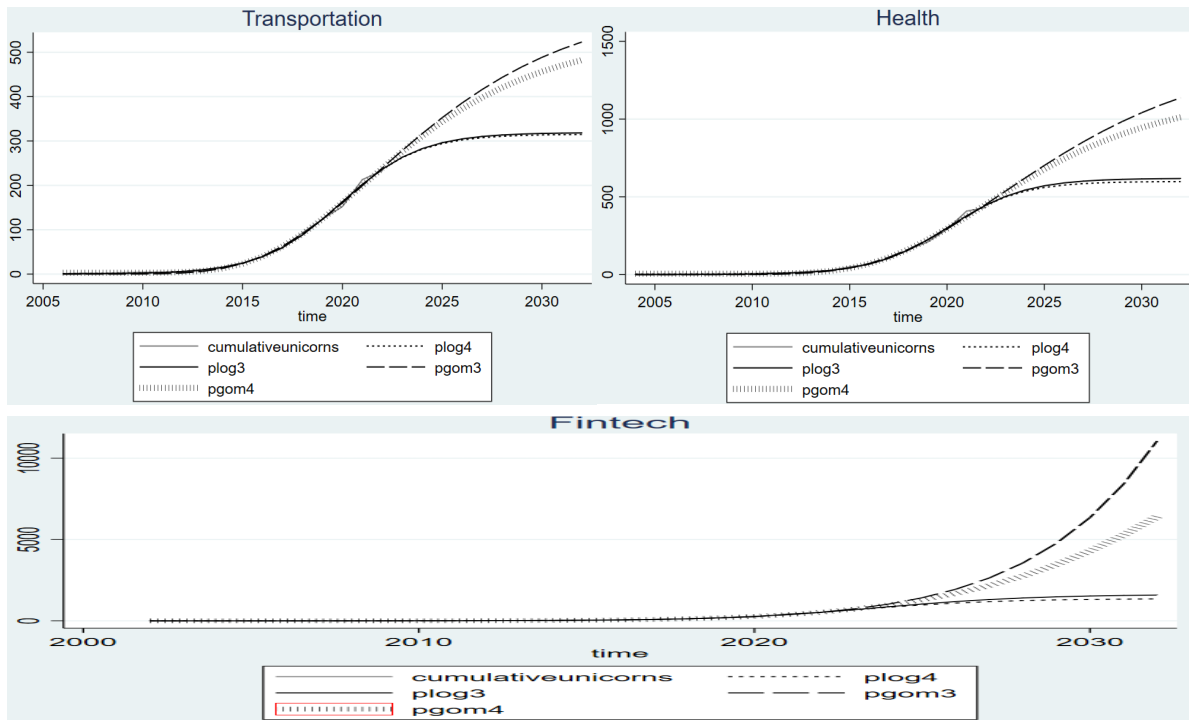


Figure 2: Diffusion and forecasting of unicorns by sectors

plog4= forecasting by LM4P, plog3 = forecasting by LM3P, pgom3= forecasting by GM3P, pgom4 = forecasting by GM4P.

Table 2: Estimated parameters of the unicorn diffusion models by sectors

Significance level: *, $p < 1\%$; **, $p < 5\%$; ***, $p < 10\%$

Parameters	Fintech (n=21)		Health (n=19)		Transportation (n=17)	
	Logistic	Gompertz	Logistic	Gompertz	Logistic	Gompertz
M_3P	1630.231***	3.11e+09	619.390*	1440.596**	318.955*	615.22*
M_4P	1 373,545**	239 642,95	599,396*	1 179,559**	315,394*	541,338*
α_{3P}	0.431*	0.022*	0.508*	0.159*	0.504*	0.176*
α_{4P}	0.459*	0.052	0.532*	0.184*	0.512*	0.196*
β_{3P}	2023.707*	2148.927*	2020.128*	2022.922 *	2019.911*	2021.68 *
β_{4P}	2023.045 *	2056.553*	2020.007*	2021.828 *	2019.87*	2021.032*
In sample						
Adj R ² _3P	0.992	0.992	0.996	0.994	0.998	0.997
Adj R ² _4P	0.989	0.988	0.995	0.993	0.996	0.996
RMSE_3P	14.75	15.026	9.925	12.301	4.598	5.098
RMSE_4P	14.967	15.639	9.986	12.062	4.750	4.905
Out of sample						
MAE_3P	6.961	6.538	5.457	7.447	2.674	3.210
MAE_4P	6.678	6.732	5.191	6.814	2.5	2.501
MAPE_3P	0.334	0.295	0.302	0.492	0.249	0.392
MAPE_4P	0.474	0.415	0.402	0.768	0.154	0.219

5. Conclusion

In this paper, we use two different growth models, namely the Logistic and Gompertz models with three and four parameters to describe the diffusion of unicorns in eight countries and three sectors. The main objective was to determine the best-fitted and the best-suited model for forecasting the future adoption of unicorns for the selected countries and sectors. Through our analyses, we find that the Logistic model with three parameters is the best at fitting and forecasting the spreading of unicorns in the USA and UK. For the case of Germany, France, Sweden, Netherlands, and India, the best model for explaining and forecasting the diffusion of unicorns is the Logistic model with four parameters. However, the Gompertz model with three parameters fits best with the actual data of cumulative unicorns in China. Unicorn diffusion in transportation, healthcare, and fintech sectors is also well described by the Logistic model with three parameters. The forecasting analysis shows that unicorns are not mythical anymore, their number will surpass 6800 in seven years.

In terms of practical implications, the variables such as the speed of diffusion, time to saturation level and the ultimate market potential, for each country and industry can help policy makers to act at the right time. As almost all the studied countries are expected to achieve their maximum level of unicorn diffusion between five and seven years, our results underline the need for policy makers to promptly establish development strategies targeted at facilitating unicorn growth. Such strategies could include an appropriate infrastructure, a properly defined regulatory framework, availability of risk capital and innovation ecosystems enabling the improvement of the business environment. As far as sectors are concerned, development strategies of unicorn growth should be focused on the three studied sectors and especially the fintech industry to promote financial inclusion and sustainability.

Considering that this paper is the first study on the diffusion of unicorns in the world, the analysis points to useful avenues for future research. Firstly, we think that the growth models have an important capacity to describe and forecast the processes of diffusion. Such models could be enhanced for getting the best model choice. We could, for example, investigate the Logistic and Gompertz models with five and more parameters. Secondly, to enable a much richer analysis, it would be useful to break up the unicorns by their year of achieving such status and undertake a longitudinal analysis of their behavior. Finally, it will be interesting to study the factors that influence the diffusion of unicorns by country and by sector.

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