# Forecasting the adoption of telecommunications services combining time-series and diffusion models

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# Sections of the presentation

- Introduction
- Aggregate diffusion models - ARIMA models
- The methodology, application and results
- Conclusions and Future directions

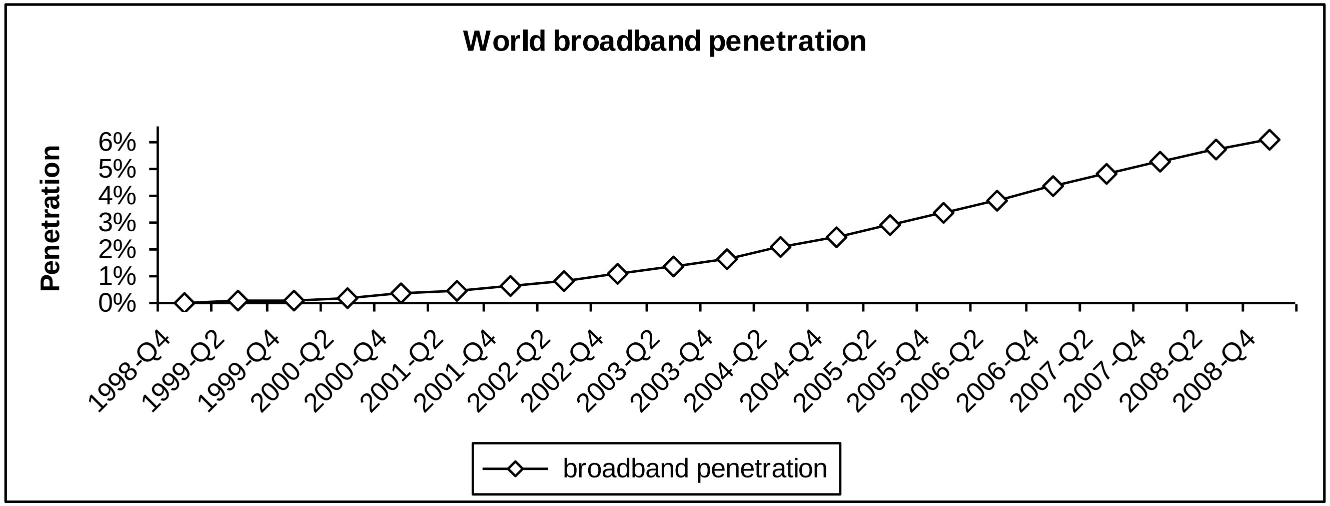
## Facts

- Accurate diffusion forecasting is vital for proper policy decisions taken from regulators, governments and companies
- Forecasting diffusion of new technologies is usually performed by the means of aggregate diffusion models
- Time-series modelling has been surprisingly neglected due to the lack of providing accurate long-term predictions

## Aim of this work

- Combination of both modelling approaches into a single framework to provide accurate short-term forecasts once the diffusion has began its rapid increase and with the prerequisite of enough historical data

- Application of the proposed methodology in the world broadband and the mobile telecommunications' penetration



# Aggregate diffusion models

The aggregated S-shaped diffusion models can be derived from a differential equation such as:

$$\frac{dN(t)}{dt} = \delta \times f(N(t)) \times [K - N(t)]$$

*N(t)* :the total penetration at time *t*

K :the saturation level of the specific technology

*δ* : the coefficient of diffusion, which describes the diffusion speed and correlates the diffusion rate with the actual and maximum penetration.

## The most popular diffusion models

- The Gompertz model

$$Y(t) = Se^{-e^{-a-b\times t}}$$

- The Linear Logistic model

$$Y(t) = \frac{S}{(1+e^{(-a-b\times t)})}$$

- The Bass model

$$A(t) = \frac{(m\times(p+q)^2)}{p} \times \frac{e^{-(p+q)t}}{[(q/p)e^{-(p+q)t}+1]^2}$$

# ARIMA models

- An ARIMA model is generally referred to as an ARIMA (*p,d,q*) model where *p*, *d* and *q* are integers, greater than or equal to zero and refer to the order of the autoregressive, integrated and moving average parts of the model, respectively.

- The ARIMA time-series analysis uses lags and shifts in the historical data to uncover patterns (e.g. moving averages, seasonality) and predict the future.

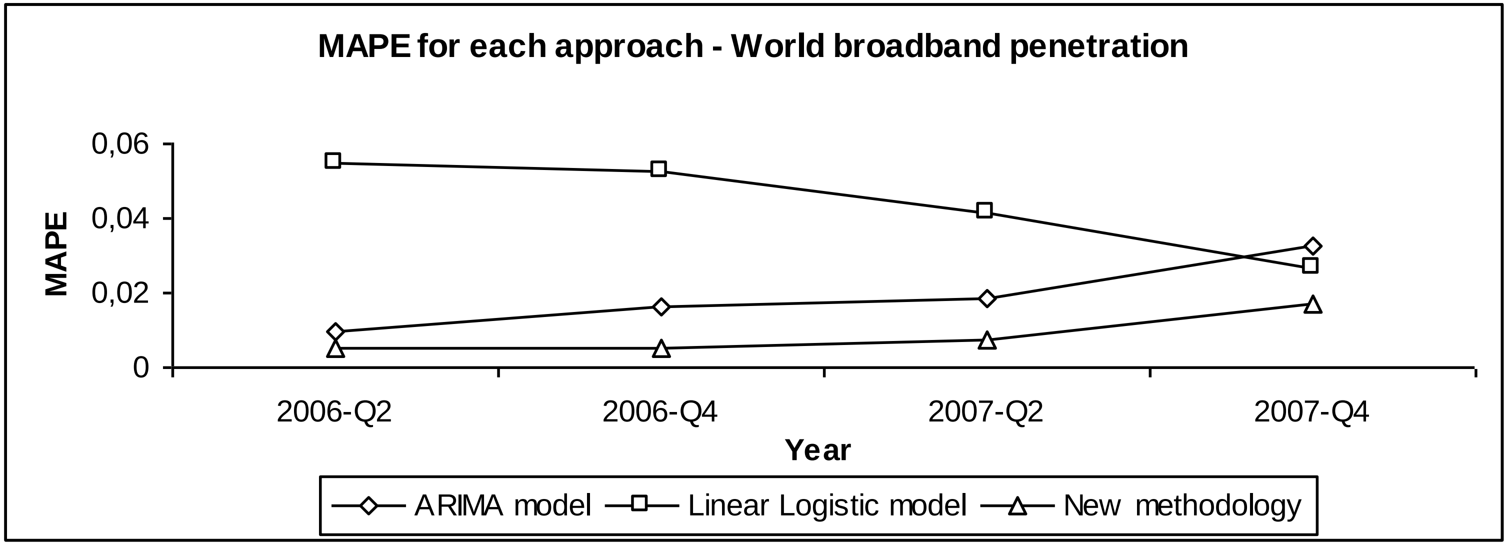
$$(1-B)^d (1-\sum_{i=1}^{p} \varphi_\iota \mathrm{B}^\iota) X_t = (1+\sum_{i=1}^{p} \theta_\iota \mathrm{B}^\iota)\varepsilon_t$$

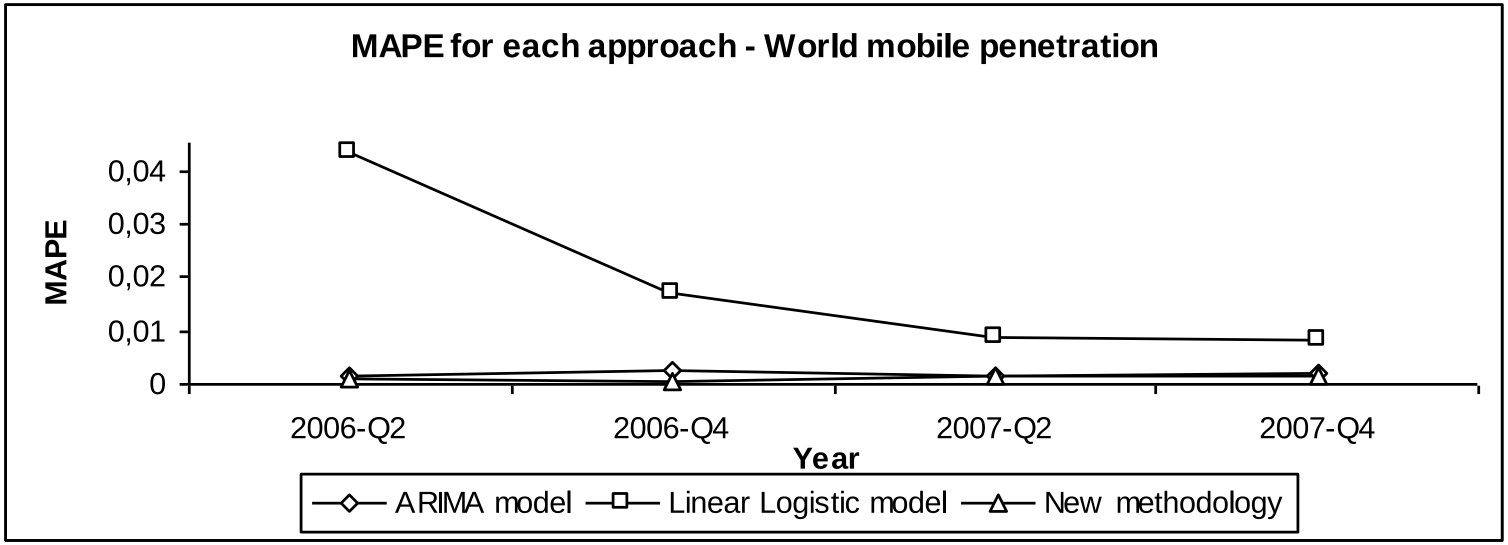
# Methodology description

- The methodology relies on the use of the first two predictions of the most suitable ARIMA model, incorporated into the diffusion model as actual data, so as to construct a new diffusion model

- After the calculation of the new model's parameters, the first two values are recalculated. These forecasts incorporate the effects of the ARIMA and the Linear Logistic models

# Results after application



# Outcomes after Application

- All three measures (MAPE, MAE, MSE) resulted that the combined model produced improved forecasts
- The earlier the ARIMA model is applied in the S-curve, the better the MAPE for this approach
- The Linear Logistic model improves its prediction from step to step, as the sigmoid curve approaches the saturation point

# Conclusions and Future directions

- When penetration is at its initial stage of rapid increase and given the availability of data, the proposed approach provides improved forecasts, as compared to each category separately
- Future research includes the application in other cases of high technology innovations, as well as the investigation of its use in other stages of the diffusion process and for longer horizons
- Finally, the combination with other forecasting models and the incorporation of telecom-related variables should also be thoroughly examined

# References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# Thank you!

# Any questions?