Forecasting long-term paper demand in emerging markets

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Abstract

Purpose – *Typically, the graphic paper demand is being forecasted with the development of GDP, population and the price of paper. Recently, diffusion of information and communication technologies (ICT) has been identified as one possible driver of its consumption. It could be assumed that in emerging markets paper demand is a combination of these classical and new factors.*

Design/methodology/approach – *The research examines the situation in the emerging Russian market with panel data regression analysis, accompanied with system dynamics simulation using Monte Carlo sensitivity analysis. So, the paper integrates different quantitative approaches to sketch long-term paper demand forecasts through different alternative scenarios.*

Findings – *Results show that mobile telephones are complementary to both newsprint and magazine paper demand and the internet is a substitute, but these two factors are still relatively small compared to the effect of GDP per capita.*

Research limitations/implications – *This research is limited to Russian markets, and in order to have more generalization power, it should be repeated in other emerging economies like, for example, former East European countries and Asia. However, used data in our analysis is longitudinal and has numerous observation points; therefore giving more reliability over the results.*

Originality/value – *The research work is seminal from the methodological point of view: it incorporates numerous quantitative methods to produce demand forecast using Monte Carlo simulation. Also, research studies taking into account the impact of ICT on emerging markets concerning paper demand are rare.*

Keywords *Paper, Emerging markets, Communication technologies, Forecasting*

Paper type *Research paper*

1. Introduction

Economic growth has historically been the most important element in further growth of paper demand – increasing gross domestic product (GDP) has resulted on increased paper consumption (Diesen, 2007). This positive relationship between paper consumption and GDP is still valid in most of the countries. However, during recent years, it seems to have diminished in some advanced economies, like US (see e.g. Hetemäki, 2005). For example, newsprint consumption started to decline in the late 1980s in this well developed market, and has mainly declined ever since, although its GDP has increased considerably (see Figure 1). According to Hetemäki (2005), newsprint consumption has stagnated or even started to decline in certain other OECD countries as well. At the same time, for example, the number of computers, mobile telephones and internet users has globally increased rapidly. As penetration rate and usage of these technologies is well established and maturing in advanced economies (Devezas *et al.*, 2005), in emerging economies their role is still unknown regarding to paper demand development, and the usage rates are still on the growth path. Due to the reason that economic growth occurs simultaneously with the adoption of information and communication technologies (ICT), situation creates interesting, and also a bit challenging, environment for predicting paper demand.

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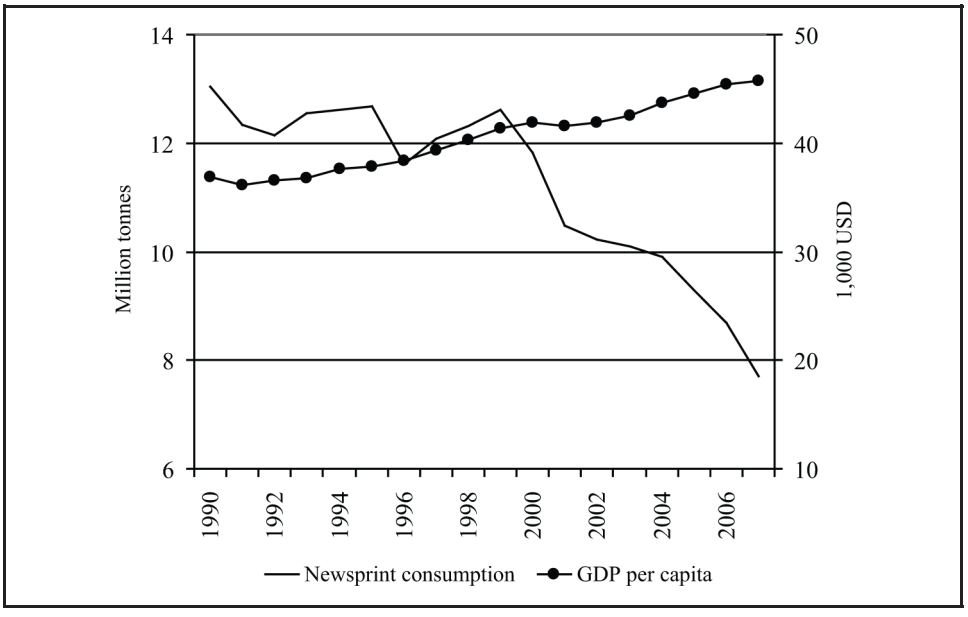
Figure 1 Consumption of newsprint and GDP per capita in the US in 1990-2007



The structural changes in pulp and paper industry dynamics are currently shifting the focus of production closer to the growing markets or the most cost-effective raw materials (similarly with other nearby industries, like furniture manufacturing, Navarro *et al.*, 2008). This is mostly caused by the distant market distribution process problems accompanied by the old style ''make to stock'' manufacturing approach (transportation costs and increased need for inventory holding; see Koskinen and Hilmola, 2008; Hämäläinen and Tapaninen, 2008; Koskinen, 2009), and decreased end product prices. Latin America and South-East Asia are the areas of focus for new investments due to their significant role in consumption of paper products (FFIFF, 2008). However, per capita paper consumption in these emerging markets is currently ranging from three to seven times lower level as compared into North-America and Europe. Knowing the factors having an effect on the long-term paper demand in these markets becomes therefore critical for pulp and paper industry. One factor that presumably has an impact on the paper demand is the penetration of information and communication technologies, among traditional economic prosperity development.

The purpose of this research work is to explore the effect of internet and mobile telephone penetration on the country level consumption of graphic papers in emerging markets and to forecast the future newsprint and magazine paper consumption in Russia using system dynamics model. We base our simulation model on the advanced regression analysis model, incorporating these factors among GDP per capita development. System dynamics model alters different parameters, and analysis shows scenarios for future paper demand in this country (typical approach in future studies as time horizon gets longer, see Popper, 2008). Outcome of this research work is not only important for export manufacturers, but also for pulp and paper manufacturers thinking about the greenfield investments into this region; country is very rich regarding to natural resources (round wood, important import country for several European countries, see e.g. Carlsson and Rönnqvist, 2005), and great political will exists to renew this industry as well as making country once again great export region of these products (Bond and Tykkyläinen, 1996; Toppinen *et al.*, 2007).

The rest of the paper is organized as follows: a short review of previous studies regarding to long-term demand forecasting using system dynamics is given in section 2. Research methodology and environment (data collection, simulation models, and used research methods) are introduced in section 3. Regression analysis and system dynamics simulation results are shown in section 4, and as a conclusions regarding to different scenarios we conclude that paper demand is increasing strongly in this emerging market, driven mostly

by economic prosperity development. We conclude our work in Section 5, and provide avenues for further research.

2. Literature review from long-term demand forecasting

There exist only a few econometric studies concerning the information and communication technology and paper demand; these are Zhang and Buongiorno (1997), Hetemäki and Obersteiner (2001), as well as Bolkesjø *et al.* (2003). In the following these are analyzed more in details.

Zhang and Buongiorno (1997) investigated the effect of electronic communication media on the demand of printing and publishing papers in the US. They concluded that ''during the period 1960-1991 the demand for printed materials was affected essentially by income and their own price, with little effect from the prices of electronic communication media'' (Zhang and Buongiorno, 1997, p. 374).

Hetemäki and Obersteiner (2001) as well as Bolkesjø *et al.* (2003) compared the classical paper demand model and its Bayesian variation. Hetemäki and Obersteiner (2001) completed forecasts concerning the US newsprint demand until the year 2020 and Bolkesjø *et al.* (2003) augmented the method for a panel data concerning Western Europe and Japan. The classical paper demand model is based on the Cobb-Douglas production function. Paper demand is the dependent variable, and gross domestic product and the real price of paper are used as regressors. In the Bayesian variation of it, both Hetemäki and Obersteiner (2001) and Bolkesjø *et al.* (2003) incorporated industry experts' extra knowledge, for example, about the substitution of newspapers by electronic media in the estimation to produce forecasts. According to Hetemäki and Obersteiner (2001), the classical paper demand model could not explain or forecast the newsprint demand in the US. Their future forecasts of the Bayesian models also indicated only a slight decline in newsprint consumption compared to year 2000 Results of the Bolkesjø *et al.* (2003) indicated that the Bayesian approach may have an advantage in comparison with the classical model of paper demand.

It seems that in the previous literature there has not existed that much research concerning utilization of system dynamics simulation models to forecast paper demand (or other forest product demand; from forest industry there exist, e.g. Davidsdottir and Ruth, 2005). This is rather surprising finding, taking into consideration that Lyneis (2000) argues that by using system dynamics models can be produced more reliable forecasts than by using statistical models. In other industries the use of system dynamics simulation in forecasting purposes appears to be more common. In the following is given some examples.

Van Vuuren *et al.* (1999) described a systems dynamics model to simulate long-term scenarios in the production and demand of some metals. Driving forces were e.g. decline in ore garde, capital and energy costs as well as waste flows. Davidsdottir and Ruth (2005) developed a model to the US pulp and paper industry that incorporated investment decisions, vintage structure of the capital stock, material and energy flows and paper demand as well as simulated industrial futures until 2020. They concluded that the price of energy has an important role in decision making in the pulp and paper industry, and energy prices are important drivers for industrial change. Fan *et al.* (2007) forecasted investments, production, and production capacity of coal mines as well as available coal reserves in China until 2020 by using system dynamics models. Tao and Li (2007) simulated the so-called Hubbert's Peak for the oil production concerning China. They concluded that the Hubbert's Peak of the crude oil in China will probably materialize in 2019-2022. Bush *et al.* (2008) developed a system dynamics model to forecast different scenarios for cellulose ethanol production in the US, to help decision makers to accelerate the utilization of bio fuels.

As in this research work we utilize Monte Carlo sensitivity analysis concerning system dynamics simulation results, it is important to position this current research regarding this rather rare field of application. According to our knowledge, there exist only two journal level publications from this; namely Fiddaman (2002) concerning climate-economy interaction

regarding new emission polices, and Miller and Clarke (2007) analyzing the investment approaches within airports.

3. Research methodology and environment

3.1 Data

Paper types investigated in this study are newsprint and magazine paper (coated mechanical paper). Newsprint is uncoated paper used in newspapers, flyers, telephone directories etc. and coated mechanical papers are used in magazines and in commercial printing (catalogs, brochures etc.). Country-level annual panel data were used in the regression analyses to determine the regression coefficients used in system dynamics simulation for future paper consumption. Countries were chosen by selecting all available countries included in the Morgan Stanley Emerging Market Index (MSCI, 2006). Data on newsprint includes 22 countries and data on magazine paper 11 countries. Countries are from Latin America, Europe, Asia and Africa. Both samples include Brazil, China and Russia. Main difference between the data sets is the lack of other Asian countries than China in magazine paper data.

The annual country level paper demand was defined by apparent consumption (with equation of ''production'' and ''imports'' summed together, which is thereafter deducted by exports). Data on production, imports and exports from 1990 to 2007 were obtained from the Industry Statistics Database provided by RISI. Gross domestic products and populations in 1990-2007 were gathered from the Global Market Information Database (GMID) provided by Euromonitor International. GDP was measured at constant US dollars at 2007 prices and fixed 2007 exchange rates, and it was converted to GDP per capita. Estimates of the Russian birth and death rates used in the system dynamics forecast model were also gathered from GMID. Internet and mobile telephone penetration rates in 1990-2007 were obtained from the World Telecommunication/ICT Indicators 2007 Database provided by International Telecommunication Union (ITU). Penetration rates were measured as numbers per 100 people.

3.2 Regression model and estimation methods

The effect of internet and mobile telephone penetration on the paper consumption in emerging markets was investigated using the following *ad hoc* model:

$$\ln(C_{it}) = \alpha_i + \beta_1 \ln(GDP_{it}) + \beta_2 \ln(INT_{it}) + \beta_3 \ln(MOB_{it}) + \varepsilon_{it}, \quad (1)$$

where i is the country index, t is the year, C_{it} is the per capita paper consumption, GDP_{it} denotes gross domestic product per capita, INT_{it} is the internet penetration rate and MOB_{it} is the penetration rate of mobile telephone subscribers. α_i denotes country-specific effect and ε_{it} is the error component. In this model specification, the regression coefficients β_1, β_2 and β_3 are common to all countries and years. All differences between countries and over time are captured by the country-specific effects α_i (e.g. Hill *et al.*, 2008). Both dependent and independent variables are in natural logarithms in order to achieve linearity.

We also considered time as an explanatory variable by adding it among the regressors. With magazine paper, the effect of time on consumption was insignificant. With newsprint, the effect of time was negative and significant at the 5 percent level. However, there presumably is strong multicollinearity between the ICT-variables and time. In addition, the coefficient of determination increased only slightly compared to the model specification without time (from 0.677 to 0.696) so that we decided to exclude the time variable from our regression model. We thus assume that in emerging markets the diffusion variables are able to explain the effect of ICT on newsprint consumption. Instead, in the most advanced economies, where the ICT penetration rates are little by little leveling off, the time presumably would be an important factor to capture the effect of changes in people's media consumption behavior.

Model (1) was estimated by using both fixed effects and random effects estimation with statistical package Stata 10. In fixed effects estimation, country-specific effects α_i are fixed parameters and explanatory variables are assumed to be independent of the ε_{it}. Parameters

α_i can be either treated as dummy variables or they can be eliminated by using so called fixed effect estimator. In this study, the latter method was used. If one is interested in those country specific parameters (like we are interested in that of Russia), α_i can be easily ''recovered'' even if the fixed effects estimator is used during estimation (Hill *et al.* 2008). In random effects estimation, α_i are assumed to be random parameters rather than fixed, and they act as an error term together with ε_{it}. Regressors are assumed to be independent of both α_i and ε_{it}, for all *i* and *t* (see e.g. Wooldridge, 2002).

The random effects model suffers from inconsistency, if there is correlation between regressors and country specific effects. The Hausman specification test was therefore used to determine which one of the model specifications, the fixed effects or the random effects, would be more efficient. The Hausman test tests the orthogonality of the random effects and explanatory variables. The random effects model is efficient under null hypothesis, but inconsistent under alternative hypothesis (e.g. Wooldridge, 2002).

3.3 System dynamics model

Scenarios for newsprint and magazine paper consumption in Russia during 2008-2020 were forecasted using system dynamics model (shown in Figure 2). In our model, the mobile telephone adopters-variable denotes the future mobile telephone penetration rate and correspondingly internet adopters represent the future internet penetration rate. Parameters *m*, *p* and *q* are so called diffusion parameters of the Bass diffusion model:

$$n(t) = p(m - N(t)) + \frac{q}{m} N(t)(m - N(t)) \quad (2)$$

where $n(t)$ is the number of adopters at time *t*, *p* is the coefficient of innovation (adoptions due to innovators), *m* represents the market potential, $N(t)$ is the cumulative number of adopters at time *t* and *q* is the coefficient of imitation (adoptions due to interpersonal communications; see e.g. Mahajan *et al.*, 1995).

Diffusion parameters *m, p* and *q* of both internet and mobile telephone penetration rate in Russia were estimated from the data provided by ITU using statistical program called SPSS. The diffusion time *t* was from 1990 to 2020. Estimated parameters are shown in Table I. Both internet and mobile telephone penetration rate were measured per capita during estimations.

Figure 2 Used system dynamics model

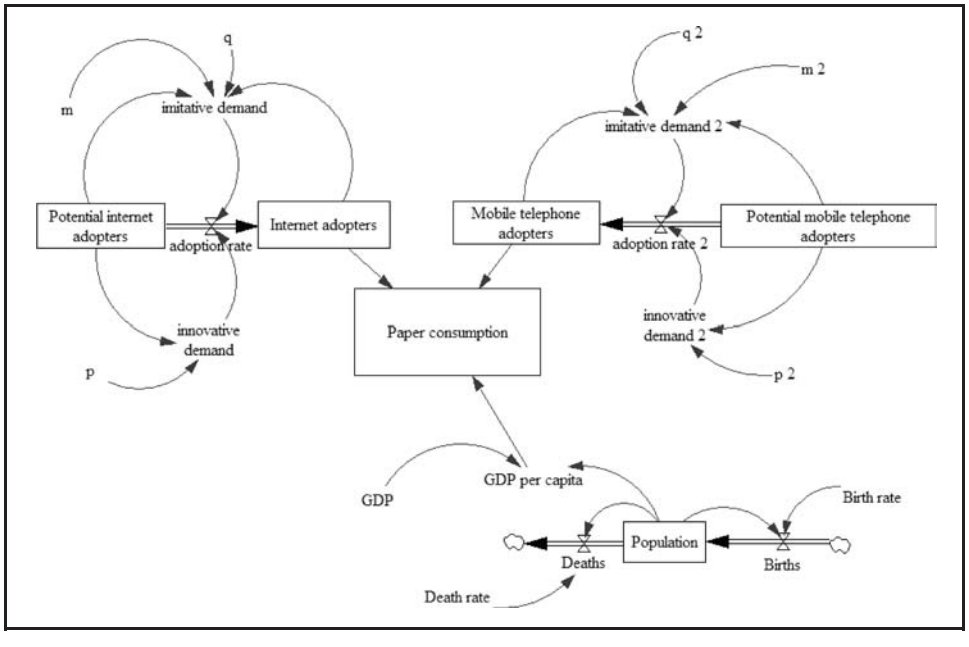


Table I Estimated diffusion parameters concerning internet users and mobile telephone subscribers

	Parameter	Estimate	Std. Error	95 percent confidence interval Lower bound	Upper bound
Internet	p	3.88E-005	0.000	−2.71E-007	7.80E-005
Users	q	0.649	0.042	0.560	0.738
	m	0.236	0.010	0.215	0.257
Mobile	p_2	2.86E-007	0.000	1.60E-007	4.11E-007
Telephone	q_2	0.977	0.015	0.944	1.010
Subscribers	m_2	1.287	0.010	1.266	1.308

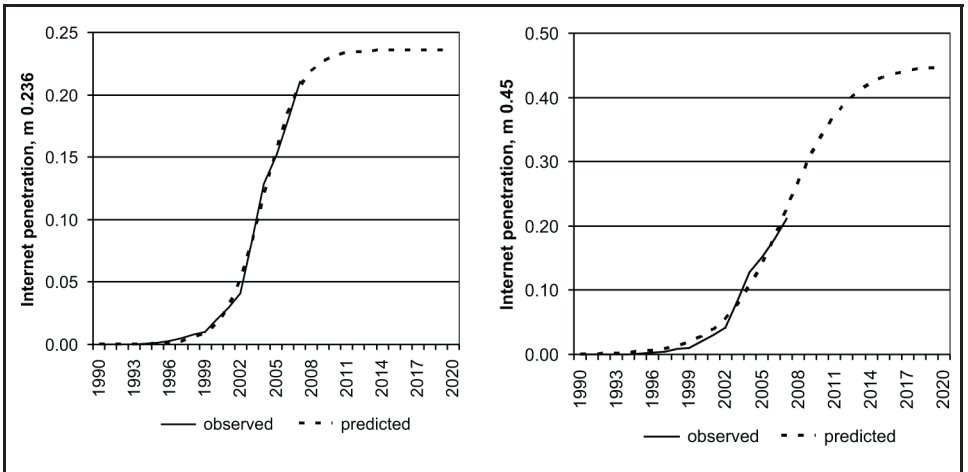
As shown in Table I, the estimated market potential of the internet, *m*, is 0.236 meaning the number of the internet users per 100 people to be only 23.6 in 2020. This seems quite low, given that in 2007 the number was already 21.1. Diffusion parameters of the internet users were therefore estimated using slightly different method as well. The market potential *m* was set to be 0.45 and only the innovation and imitation coefficients *p* and *q* were estimated. Estimated parameters are shown in Table II. Basic scenarios for the Russian paper consumption were calculated using market potential estimated from the data (0.236) and the effect of higher potential (0.45) on the consumption was also tested.

Observed vs predicted internet penetration rates in 1990-2020 in Russia are shown in Figure 3. The market potential is either 0.236 or 0.45 in this market development evaluation. Corresponding figure for the mobile telephone penetration rate is shown in Figure 4. As could be noted, mobile phone user growth is leveling off, and internet usage is about to

Table II Estimated innovation and imitation coefficients of the internet users (market potential is having value of 0.45)

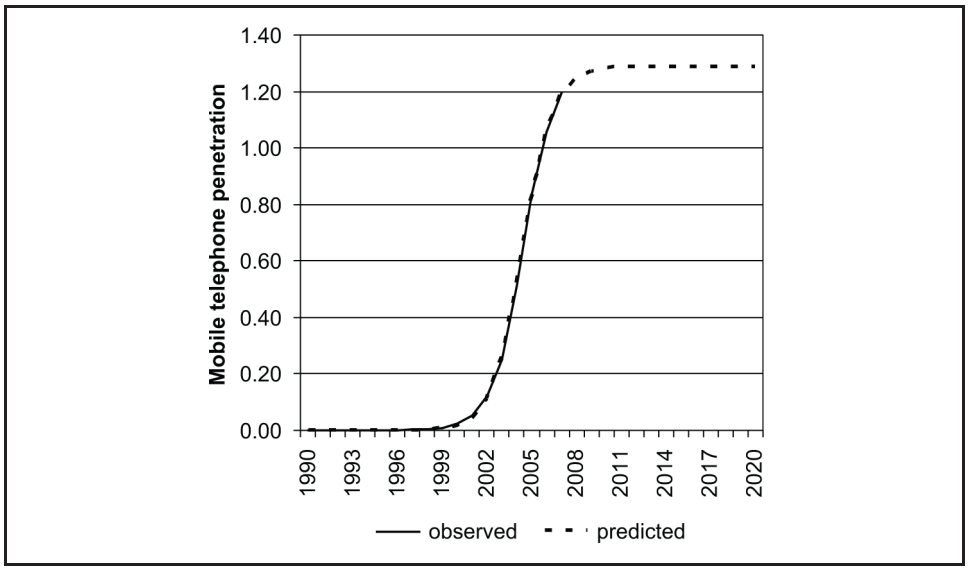
Parameter	Estimate	Std. Error	95 percent confidence interval Lower bound	Upper bound
p	3.380E-004	1.038E-004	1.180E-004	5.580E-004
q	0.392	0.023	0.344	0.440

Figure 3 Observed and predicted internet penetration rates (per capita) in Russia. Market potential is 0.236 (left) and 0.45 (right)



Note: Market potential is 0.236 (left) and 0.45 (right)

Figure 4 Observed and predicted mobile telephone penetration rates (per capita) in Russia



continue its growth at minimum until early year 2010, however, in more positive scenario its growth could continue for approx. next seven years.

As shown in Figure 3, there is no notable difference in the fit between the internet penetration rate models. Both fit the observed values quite well. Predicted values of the mobile telephone penetration rate fit the observed values nearly perfectly.

In the system dynamics model (see Figure 2) the GDP variable is exogenous, and is gained from Excel spreadsheet. It is thereafter converted into GDP per capita by dividing by the amount of population. Simulation uses 3, 5, and 8 percent annual growth rates of GDP in basic scenarios. Also the effect of slower annual growth (2 percent) was tested due to current economic slow-down, which could continue for years due to declining economic long-cycle (see Ayres, 2006; Hilmola, 2007).

Russian population in 2008-2020 was simulated by using birth and death rates. In Figure 5 there are observed birth and death rates along with population in Russia during 1992-2007. As shown, the population has decreased since the mid-1990s. During last five or six years the death rate has been about 16 per 1,000 people and the birth rate about 10 per 1,000 people. In the basic scenarios the population was assumed to continue decreasing so that the annual birth rate of 0.0105 and death rate of 0.0163 were used. The impact of population staying at a similar level to what it was in 2007 was also tested.

Uncertainty in the system dynamics model was built with sensitivity simulation (using Monte Carlo application in system dynamics simulation program). Uniformly distributed randomness was added to the diffusion parameters and on birth as well as on death rates. Lower and upper bound of the 95 percent confidence interval of the estimated coefficients were used as minimum and maximum values of the distribution with the diffusion parameters. Birth rate varied uniformly between 0.00095 and 0.00115 and death rate between 0.0153 and 0.0173. Number of simulations was set to 200.

Different future newsprint and magazine paper consumption scenarios in Russia were simulated by varying growth rate of GDP, death and birth rates and market potential of the internet penetration rate. Basic scenarios were calculated by using both fixed and random effects model for the paper consumption, but only the random effects model was used in other simulations. Scenarios are summarized in Table III.

Figure 5 Population and birth and death rates in Russia during time period of 1992-2007

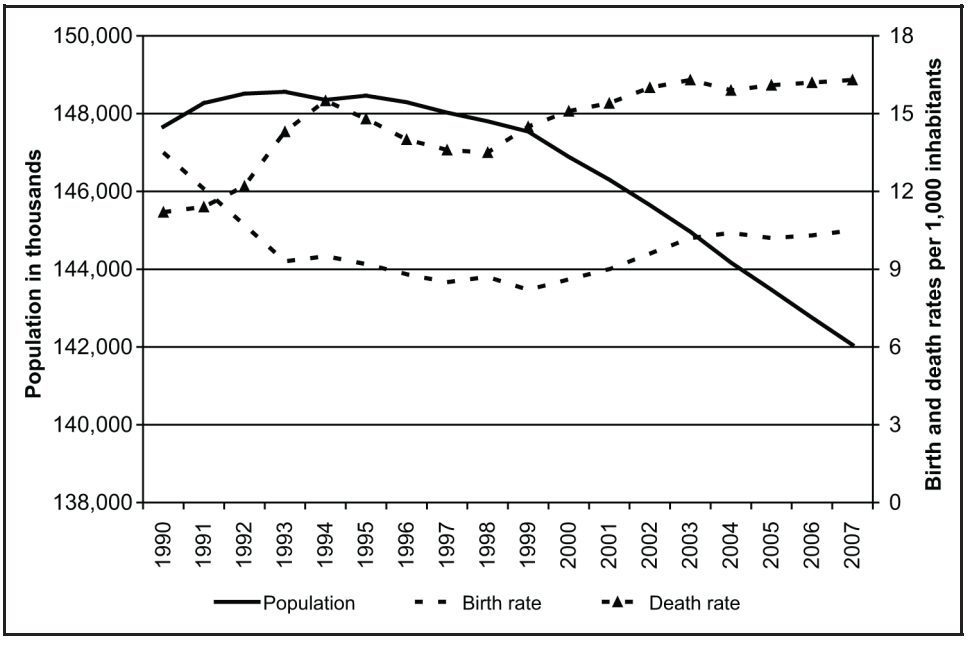


Table III Tested simulation scenarios of this study (FE/RE = fixed or random effects model)

Scenarios	*Paper consumption model*	*Growth rate of GDP (%)*	*Population*	*Market potential of the internet*
Basic	FE, RE	3	Decreases	0.236
	FE, RE	5	Decreases	0.236
	FE, RE	8	Decreases	0.236
Effects of	RE	2	Decreases	0.236
Population	RE	2	At 2007 level	0.236
and GDP	RE	5	At 2007 level	0.236
Effect of the higher internet penetration rate	RE	2	Decreases	0.450

4. Long-term system dynamics simulation results

4.1 Regression analyses

Table IV provides descriptive statistics for the variables used in the regression analyses. Sample sizes are 22 countries (newsprint) and 11 countries (magazine paper) and the time period is 1990-2007. As shown, the mean values of the explanatory variables vary by paper grade, owing to different samples. Values in the data of magazine paper are slightly higher than in newsprint data.

Table V reports estimated regression coefficients and model fitting statistics for newsprint and magazine paper consumption. Coefficients are common to all 22 (newsprint) and 11 (magazine paper) countries included in the analyses. Country specific effects of Russia are reported in Table V as well but for the other countries α_i are excluded for convenience. Constant term is the average of individual country-specific effects. Model 1 is a fixed effects model and model 2 is a random effects model.

As shown in Table V, estimated coefficients between fixed effects and random effects models are similar. Coefficients of the GDP per capita are positive and significant for both paper grades. Estimated coefficients of mobile telephone penetration rate are positive and statistically significant in random effects models. Coefficients for internet penetration rate are

Table IV Descriptive statistics with respect of paper grade

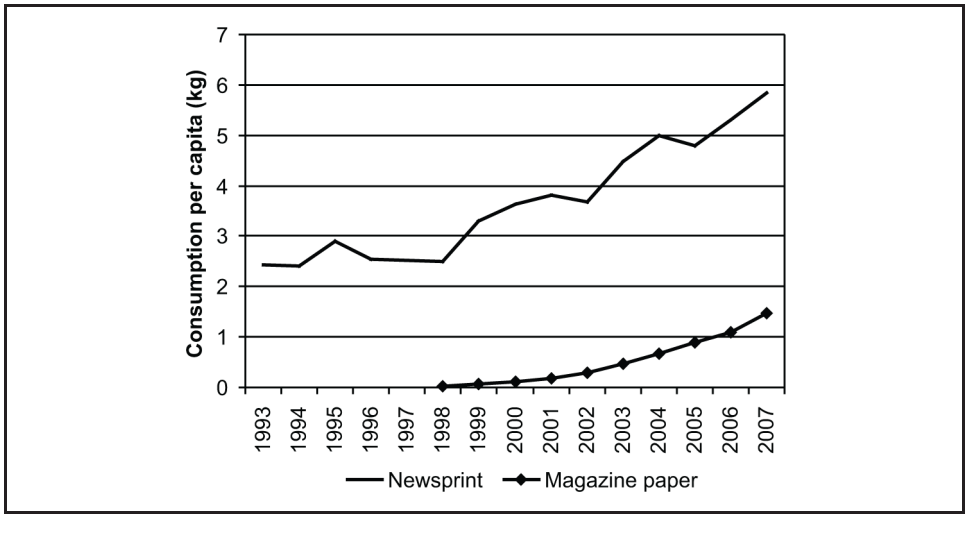
	Mean	*SD*	*Min*	*Max*
Newsprint				
Paper consumption per capita (kg)	4.0	3.5	0.3	18.5
GDP per capita (1,000 US$)	2 957	2 229	311	13 863
Mobile telephone penetration (per 100 people)	15.1	23.3	0.0	118.4
Internet penetration (per 100 people)	6.4	10.0	0.0	67.1
Magazine paper				
Paper consumption per capita (kg)	1.9	1.9	0.0	8.7
GDP per capita (1,000 US$)	3 841	2 458	358	13 863
Mobile telephone penetration (per 100 people)	19.4	28.0	0.0	118.4
Internet penetration (per 100 people)	7.3	11.1	0.0	67.1

Table V Estimated regression coefficients for newsprint and magazine paper consumption

	Newsprint		*Magazine paper*	
	Model 1 Fixed effects (Within, OLS)	*Model 2 Random Effects (GLS)*	*Model 1 Fixed effects (Within, OLS)*	*Model 2 Random Effects (GLS)*
GDP per capita	0.882**	0.866**	1.818*	1.532**
(1,000 US$)	(0.291)	(0.108)	(0.816)	(0.291)
Mobile telephone penetration	0.067	0.068**	0.261***	0.287**
(per 100 people)	(0.041)	(0.019)	(0.123)	(0.078)
Internet penetration	−0.060*	−0.061**	−0.185	−0.193*
(per 100 people)	(0.025)	(0.014)	(0.105)	(0.081)
Constant term	−6.137*	−6.025**	−15.928*	−13.459**
	(2.349)	(0.836)	(6.953)	(2.525)
Country specific effects of Russia	−6.333	−6.193	−8.34	−14.845
	(NA)	(NA)	(NA)	(NA)
F-test	7.79**	–	11.38**	–
Wald-test (chi^2)	–	185.33**	–	94.92**
Overall R^2	0.677	0.678	0.696	0.703
Observations	313	313	127	127
Number of countries	22	22	11	11
Hausman specification test (chi^2)	0.22		1.14	

Notes: Robust standard errors are given in parentheses; *$p<0.05$; **$p < 0.01$; ***$p < 0.10$

Figure 6 Newsprint and magazine paper consumption in Russia during time period of 1993-2007

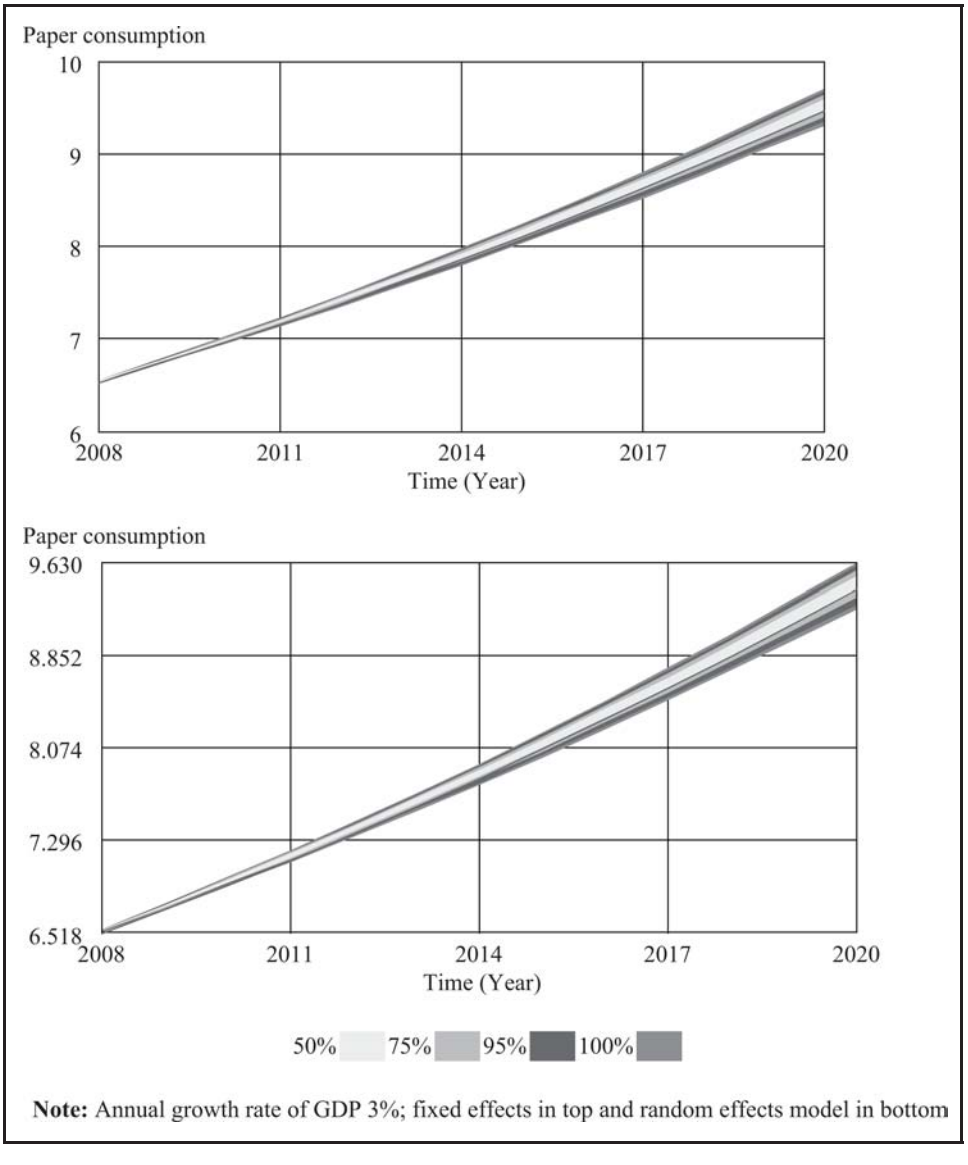


negative and different from zero at least at a 5 percent significance level, except for that of fixed effects model, which concerns magazine paper. Overall values of the coefficient of determination are moderately indicating (0.677-0.703) that explanatory variables are able to explain about 70 percent of the variation in paper consumption in these countries. According to the Hausman specification test, the random effects model is more appropriate with both newsprint and magazine paper since the null hypothesis cannot be rejected.

4.2 Scenarios for future paper consumption in Russia

Observed apparent consumptions of newsprint and magazine paper in Russia are shown in Figure 6. As shown, both are booming. For example, per capita consumption of newsprint has more than doubled in ten years. In 2007, the consumption of newsprint was slightly below 6 kg/capita and magazine paper approx. 1.5 kg/capita.

Figure 7 Scenarios for newsprint consumption during time period of 2008-2020 (annual growth rate of GDP 3 percent; fixed effects in left and random effects model in right)



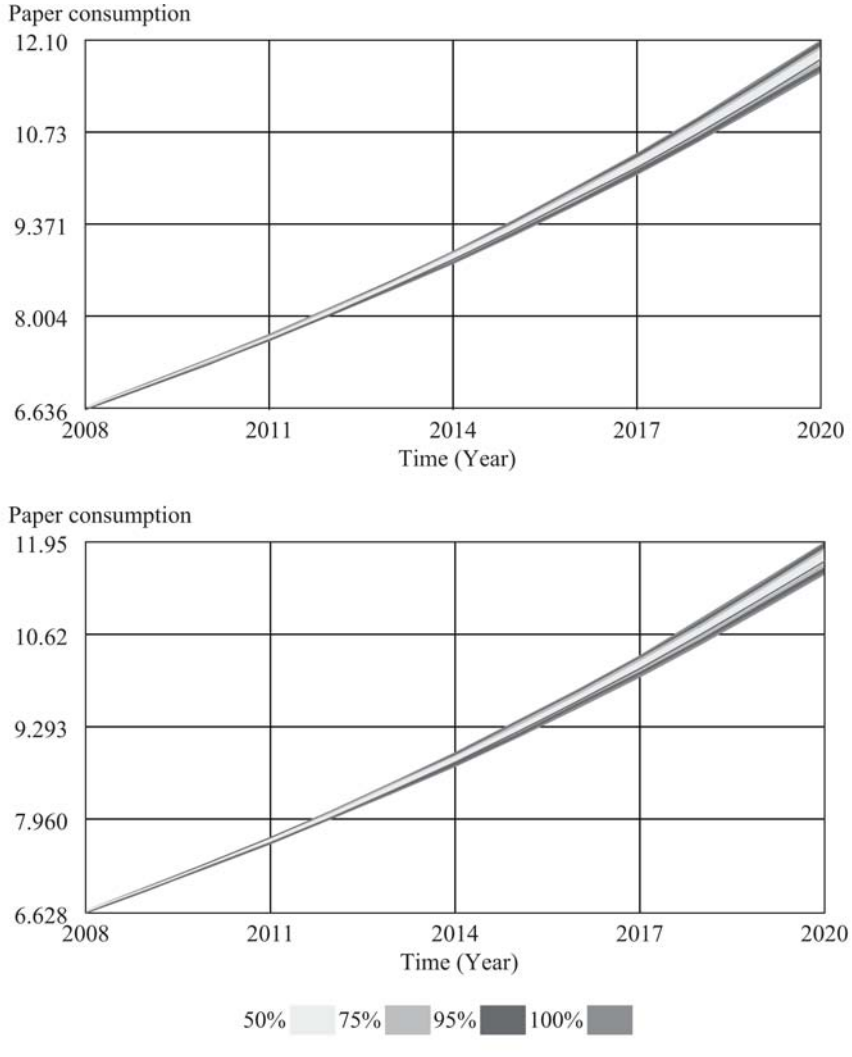
Note: Annual growth rate of GDP 3%; fixed effects in top and random effects model in bottom

Basic scenarios for the future newsprint and magazine paper consumptions in Russia are shown in Figures 7–12.

According to the simulations, both newsprint and magazine paper consumption in Russia will grow rapidly and they heavily depend on the growth of GDP. For example, if the random effects model is used, the newsprint consumption in 2020 will be about 9.5 kg/capita, if the GDP grows 3 percent annually, but will reach over 16 kg/capita, if the annual growth rate is 8 percent. Newsprint consumption forecasts seem to be quite realistic compared to the observed consumptions in 1993-2007, but with magazine paper both models clearly underestimate the future consumption. During year 2007 the observed magazine paper consumption in Russia was about 1.5 kg/capita (see Figure 6), but in all of the forecasts the consumption in 2008 is only about 1 kg/capita, which is not a realistic result.

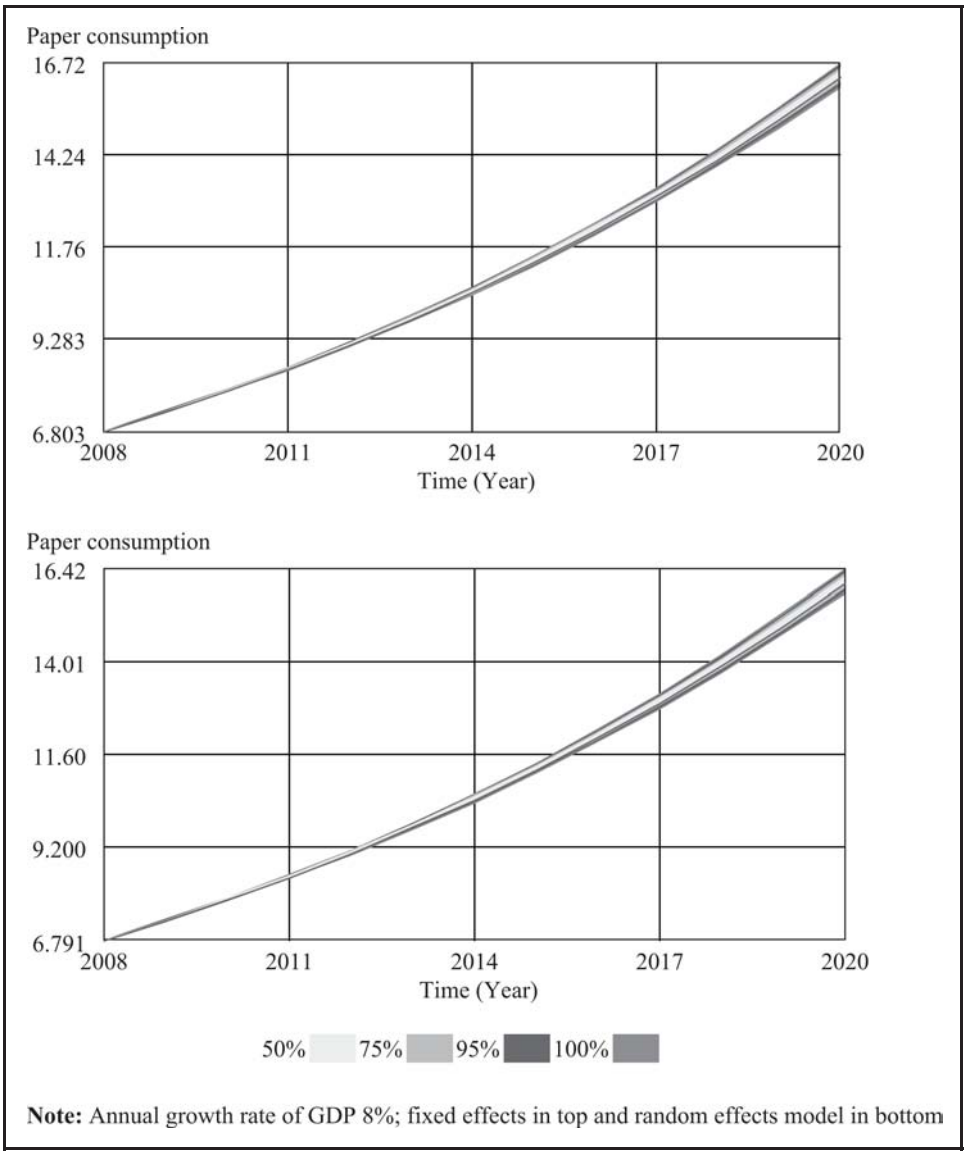
Especially magazine paper consumption forecasts are noticeably higher, if the fixed effects model is used in calculating the paper consumption compared to the random effects model.

Figure 8 Scenarios for newsprint consumption during time period of 2008-2020 (annual growth rate of GDP 5 percent; fixed effects in left and random effects model in right)



Note: Annual growth rate of GDP 5%; fixed effects in top and random effects model in bottom

Figure 9 Scenarios for newsprint consumption during time period of 2008-2020 (annual growth rate of GDP 8 percent; fixed effects in left and random effects model in right)



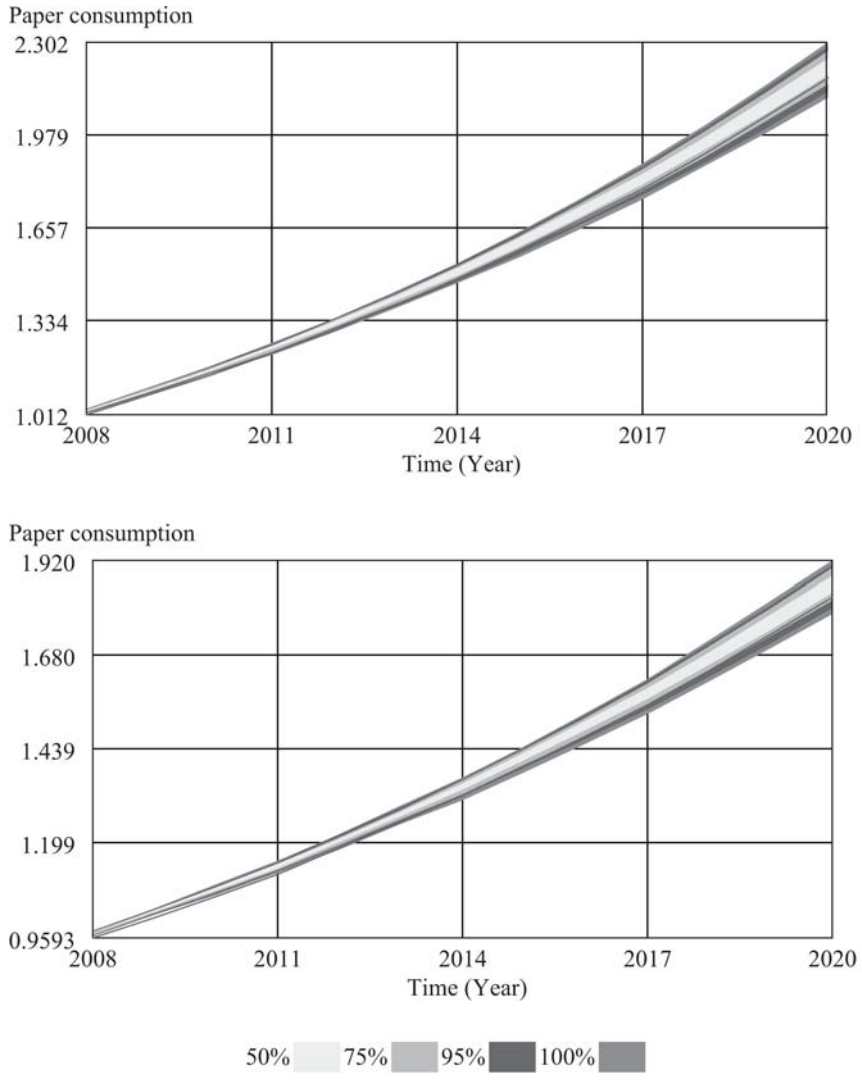
Note: Annual growth rate of GDP 8%; fixed effects in top and random effects model in bottom

Based on the results of the Hausman specification test, the random effects model is more appropriate with both of these paper grades (see Table V), so that the random effects model forecasts presumably are the more reliable ones.

Tables VI and VII are alternative scenario tables showing the average values of simulated paper consumptions in the year 2020. Different scenarios are: annual growth rate of GDP slows down/stays relative high and the population continues to decrease/stays at a 2007 level.

The strong dependence between paper consumption and the growth of GDP is clearly apparent in Tables VI and VII. The average simulated value of newsprint consumption in the year 2020 is almost 40 percent higher, if the GDP grows 5 percent annually compared to 2 percent annual growth. With magazine paper the difference between 2 and 5 percent annual growth rates is even higher. Average magazine paper consumption nearly doubles, if the growth rate of GDP increases from 2 to 5 percent.

Figure 10 Scenarios for magazine paper consumption during time period of 2008-2020 (annual growth rate of GDP 3 percent; fixed effects in left and random effects model in right)

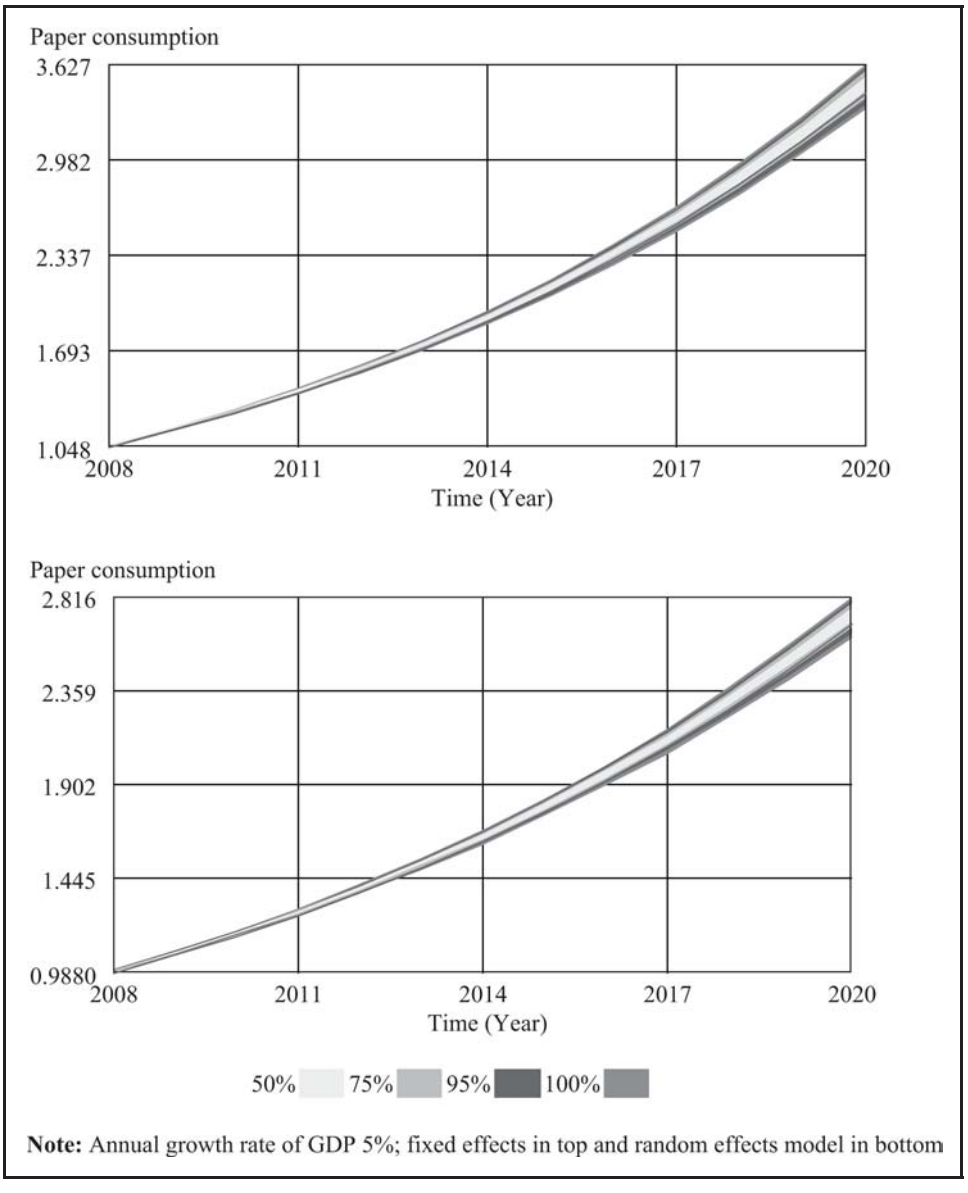


Note: Annual growth rate of GDP 3%; fixed effects in top and random effects model in bottom

The effect of population on the per capita consumption concerning both paper grades seems to be negative. If the Russian population stays at the year 2007 level, the average consumption of both newsprint and magazine paper in 2020 will be lower in contrast to the scenario of decreasing population. This finding is in line with the fact that the per capita paper consumption has strongly increased in Russia, although the population has decreased since the mid-1990s. Also in some other emerging markets (such as in Estonia, Poland and Romania) the paper consumption has increased, despite the decreasing or stagnating population – more wealth is just spread around with smaller population. This holds especially in Russia's case, since natural resources rich country basis still today 60 percent of its export into oil and gas (see Bank of Russia, 2009).

The effect of higher internet penetration rate on the future paper consumption in Russia is shown in Tables VIII and IX. Tables present the average values of simulated paper consumptions in the year 2020 if the market potential remains low (0.236) or increases

Figure 11 Scenarios for magazine paper consumption during time period of 2008-2020 (annual growth of GDP 5 percent; fixed effects in left and random effects model in right)



Note: Annual growth rate of GDP 5%; fixed effects in top and random effects model in bottom

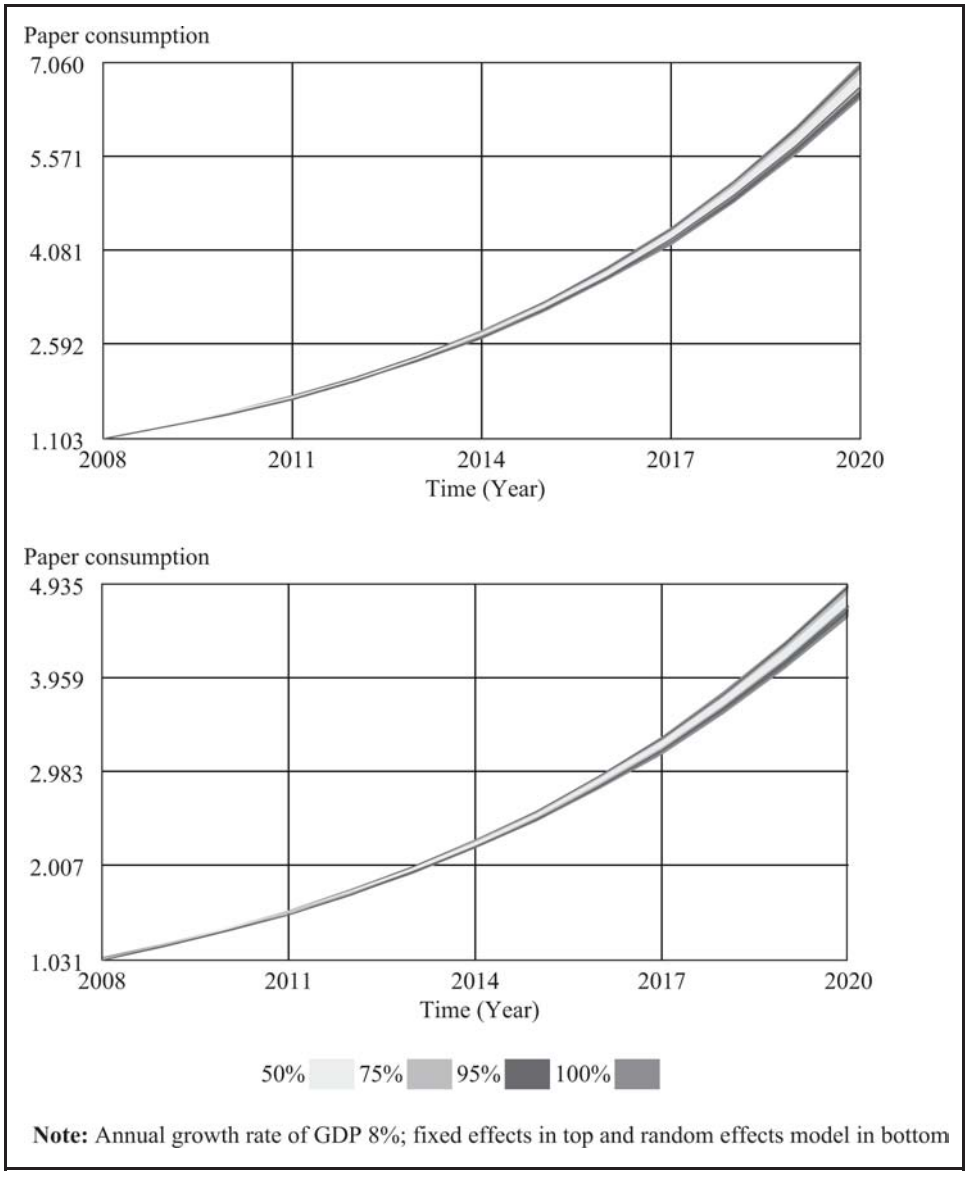
noticeably (0.450). Russian population was assumed to decrease in all of the following scenarios and the annual growth rate of GDP was set to 2 percent.

As shown the higher is the market potential, the lower is the average per capita paper consumption in year 2020. However, this negative impact of internet penetration rate on the paper consumption in Russia is relatively small. In a case of 45 internet users per 100 inhabitants in 2020, the newsprint consumption will be about 5 percent lower compared to internet penetration rate of 23.6 users per 100 inhabitants. With magazine paper the difference in consumption is about 15 percent between lower and higher market potential.

5. Conclusions

In seems to be relatively clear, that mobile telephone and internet penetration rates have some impact on paper consumption in emerging markets. The number of mobile telephone

Figure 12 Scenarios for magazine paper during time period of 2008-2020 (annual growth rate of GDP 8 percent; fixed effects in left and random effects model in right)



Note: Annual growth rate of GDP 8%; fixed effects in top and random effects model in bottom

Table VI Average, minimum and maximum simulated newsprint consumption (kg/capita) during year 2020 in Russia

	Population	
Annual growth rate of GDP	*Decreases*	*Stays at a 2007 level*
2 percent	Average: 8.46 Min: 8.26 Max: 8.63	Average: 7.58 Min: 7.52 Max: 7.65
5 percent	Average: 11.70 Min: 11.48 Max: 11.95	Average: 10.48 Min: 10.40 Max: 10.59

Table VII Average, minimum and maximum simulated magazine paper consumption (kg/capita) during year 2020 in Russia

Annual growth rate of GDP	*Population*	
	Decreases	*Stays at a 2007 level*
2 percent	Average: 1.53 Min: 1.47 Max: 1.58	Average: 1.34 Min: 1.31 Max: 1.36
5 percent	Average: 2.73 Min: 2.62 Max: 2.81	Average: 2.64 Min: 2.59 Max: 2.70

Table VIII Simulated newsprint consumption (kg/capita) during the year 2020 in Russia

Market potential of the internet	
0.236	*0.450*
Average: 8.46 Min: 8.26 Max: 8.63	Average: 8.09 Min: 7.91 Max: 8.28

Table IX Simulated magazine paper consumption (kg/capita) during the year 2020 in Russia

Market potential of the internet users	
0.236	*0.450*
Average: 1.53 Min: 1.47 Max: 1.58	Average: 1.33 Min: 1.27 Max: 1.38

subscribers per 100 inhabitants seems to grow together with the consumption of newsprint and magazine paper. Instead, internet seems to be the substitute to the consumption of these grades. However, these effects are small compared to the effect of GDP per capita, which strongly affects the paper consumption in emerging markets (unlike in advanced economies): increasing gross domestic product increases the paper consumption. System dynamics modeling and sensitivity analysis was found to be useful method to forecast the future paper consumption in Russia. It seems that the per capita consumption of these paper grades will grow rapidly during the period of 2008-2020. The simulation results show that there is a strong positive dependence between paper consumption and growth of GDP in Russia, especially with magazine paper. The country's mobile telephone is already about 120 subscribers per 100 inhabitants and most likely will not grow much above that, so that its complementary impact on future paper consumption in Russia is negligible. Instead, the higher internet penetration rate will result in lower newsprint and magazine paper consumption, but this negative impact is relatively small e.g. compared to the effect of lower annual growth of GDP. Overall, it can be said that future scenarios of the newsprint consumption are realistic, but with magazine paper some re-estimations and simulations are needed to be completed to avoid underestimation.

Suggestion for future research is to use slightly different variables to measure the effect of IC-technologies on paper consumption to obtain more reliable results. For example, the amount of data transferred via the internet or mobile telephone minutes could be used. Another suggestion for future research is to use oil related variables to explain the GDP growth in Russia in system dynamics model, as proposed in Terk *et al.* (2007, pp. 57-65) and Lättilä (2009, pp. 47-48), instead of using exogenous GDP estimate.

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