Reviewer's report

Title: Physician and nurse supply in Serbia using time-series data: A Case Study

Version: 2 Date: 17 December 2012

Reviewer: Thomas Ricketts

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Physician and nurse supply in Serbia using time-series data: A Case Study

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Background

Policy makers often promote strategic planning of human resources for health (HRH) as a part of reforms aimed at improving healthcare system performance.[1] Strategic HRH planning for attaining improved health goals and objectives encompass the understanding of the interplay among many factors within and beyond the healthcare system. Those factors include: economic policies, legislation, rules and procedures that guide health workforce production, education, deployment, performance, payment and management, as well as system health strategies, programmes, and action plans designed
to be delivered by a range of providers in settings with different socio-economic and demographic characteristics, responding to environmental threats and targeting a changing demographic structure. [2-15]

Along with that, HRH planning can include projections about cross-cutting problems regarding HRH production, employment and management, such as attractiveness of health professions, private sector role and migration of health professionals.[1-13]

During the last sixty years various tools have been developed and used for HRH planning.[2-12, 14-16]

Developed countries often used workforce supply and demand methods based on population needs-based requirements, others use benchmarking or a combination [2-12,14,15]. There are qualitative approaches (e.g. Delphi method [11]), and some studies use quantitative dynamic modeling of HRH stock and flow [14] that may include a sensitivity analysis.[15]

In all former Yugoslav republics including Serbia, HRH planning was driven by simple, normatively determined physician/dentist/nurse/pharmacists-to-population ratio. This was done in a diffused manner unconnected to overall population need as the Ministry of Education had no legal obligation to consult the Ministry of Health on the number of medical students enrolled in medical school.[16-19] In the South East European countries systematic and strategic workforce planning has been underdeveloped and understanding of migratory flows is lacking.[16]. For example, Romania has a numerus clausus and a relatively stable number of vacancies in the public sector mainly due to limitations in teaching criteria for HRH planning.[16]. A country may lack a coherent plan for HRH development, as well as valid data on HRH shortage or excess because of inaccurate databases, pitfalls in general planning, presence of a significant private sector, or lack of a responsible body and support system.[11]

Specific studies of HRH planning are limited in Serbia.[20-25] Since the Second World War, the
public sector has been the major employer and producer of health workforce in the Republic of Serbia
and by 2010 there have been three HRH strategies: the first two were long-term strategies created within
the health care development plans, by 1990 [20] and 2000 [21] respectively; and the third was part of
planned activities for the reconstruction of the health care provider network (Network) during 2005–
2010.[22] Before 1961, country had five-year economic plans, which included HRH development. Due to
scarce teaching capacity a numerous clausus was in place. HRH decision-making was decentralised to
“self managed interest communes” that aimed to increase population access and equity.[20,23] The first
HRH development plan implemented between 1974 and 1980 (?), followed the new Constitution and
Labour Law that brought broader decentralization to all former Yugoslav republics and provinces. [25]
However, after the global oil crises in 1976 the economy stagnated, the national debts rose and separatist
tensions emerged. [25] At the beginning of the 1980s, the financial restrictions on the healthcare system
and insufficiently regulated private practice forced many health workers to emigrate; this led to
centralized HRH planning. A new development plan for Serbia was enacted and was applicable between
1982 and 2000.[21] It included a reduction of enrolment in medical studies specified the number of posts
based on health worker to population ratio, and sanctioned private practice. However, military conflicts
and Yugoslavia’s break-up during 1990s curtailed the inter-sector activity over HRH development and
made banned profit making in private practice. At the end of the 20th century Serbia was an
economically degraded and isolated country, overburdened with hyperinflation, an influx of refugees
and internally displaced persons (both healthcare workers and patients).
Many health development plans were subsequently proposed by various experts, but none was
formally accepted. In 2000, the new Ministry of Health collaborated with the
World Bank on the master plan for the reconstruction of the healthcare provider network and announced a new HRH strategy for 2006–2010. [22,26] In order to fit with the reconstructed network of public healthcare providers, and attain healthcare equity, access, and to increase efficiency, the recommended staff rationalization in the public sector was aligned with private sector size estimates. The planning process posited several demand-based scenarios for primary, secondary and tertiary healthcare institutions and included population: and economic growth, healthcare services utilization, and performance benchmarking. Health workforce productivity was not included. The following year, by-laws on physician and nurse staffing and operation norms were adopted. [27,28]

Meanwhile, annual unemployment for physicians had been growing from 2000 by 5.6% and by 1.5% for nurses. Two-thirds of approximately 2,000 unemployed physicians were aged less than 30 years, and half of almost 10,000 unemployed nurses were under 25 years of age.[24] Though staffing rations had been set, there were no explicit boundaries deviation from a standard for health workforce coverage as in Slovenia (a 10% boundary on each side of the national averages).[19] The territorial staff imbalance (up to 2.74-fold for physician density and over 3-fold for specialists; and up to 1.98-fold for nurse density and over 6-fold for midwives) has persisted (Table 1). This is due to population and health workforce rural-to-urban migration, noncompliance with staffing rules and little flexibility for health workforce movement (95% of physicians and nurses have permanent full or part-time employment).

Table 1

The new Plan for Health Development between 2010 and 2015 period [29] anticipated the conception of a parallel HRH strategy but it has not yet been created. Annual staffing targets are based
on population number age and sex structure, the minimum required number and
skill-mix of workers
and performance measures for institutions. [27,28]
This is the first study that explores the past planning approaches (between 1961
and 2008)
and uses trend data from those years for forecasting physician and nurse supply
in the public
healthcare sector.
Methods
Study design and data sources
The method used to develop estimates of the Serbian physician and nurse
workforce made use
of a multivariate auto-regressive integrated moving average (ARIMA) approach.
The predicted values
(Y-variables) were the estimated number of physicians and nurses. The analysis
focused on the total
number of physicians (y1: general practitioners and specialists) and nurses (y2:
general, paediatric
nurses and midwives with secondary and high education) employed in the public
healthcare sector of
Serbia from 1961 to 2008 and their forecast numbers as of 2015. Other variables
used in the study were
the annual number of population (x1: estimates and census data for 1961, 1971,
1981, 1991 and 2002);
GDP (x2: real value at 1994 prices); inpatient care discharges (x3: proxy to
physicians and nurses
productivity in secondary and tertiary healthcare institutions), outpatient care
visits (x4: proxy to
physicians and nurses productivity in primary healthcare institutions include
prevention, curative and
rehabilitative visits in ordination and at home); students enrolled at the first year
of medical studies at
public universities (x5: proxy of high education enrolment policy); and graduated
physicians (x6: proxy
Data on physicians, nurses, outpatient care visits and inpatient care discharges
in the Network
plan of the health institution in the Republic of Serbia as of 2000 (the public
healthcare sector) were
obtained from the Institute of Public Health of Serbia.[30] HRH data from private
practice and other
institutions that were not included in the public healthcare sector were not included in the study.. The private sector comprises approximately 3% of the overall health care spending in Serbia (Milena, Snežana et al. 2011). The public healthcare sector is the major employer of health workforce in Serbia and is financed predominantly via compulsory health insurance taxes and public taxes. Data on population size, GDP and enrolled and graduated students were taken from the Statistical office of the Republic of Serbia.[31] The analysis of the education sector captured data on all the public Medical Faculties’ students in Serbia (financed via public taxes) but does not include enrolments at postgraduate or specialists studies. At the time of the analysis there were no graduation data from private faculties as they have only been recently established; [31] the estimated annual intake at private faculties is less than 3% of the total enrolment at public faculties. [24] For consistency reasons, all data refer to Republic of Serbia and exclude data from Kosovo and Metohia.

Statistical analyses

Basic descriptive statistics of variables in the study are given in table 2. The table includes longitudinal analysis of relationship among selected potential predictors and employment of physicians and nurses included analyses of all variables time-series (from 1961 to 2008) and their forecasting by 2015 (estimates with corresponding 95% lower confidence level -LCL and upper confidence level - UCL).

Table 2

Predictors of physician and nurse employment have been included in time-series models for the period 1983-2008 (potential predictors: x1, x2, x3, x4, x5, and x6) to forecast the numbers of physicians and nurses (key dependent variables: y1 and y2) employed from 2009 to 2015. Forecast outputs include absolute numbers of physicians and nurses with a corresponding 95% LCL and UCL. These
estimates represent the workforce required for Serbian public healthcare sector per year, assuming the relationships among the observed input variables (number of population, GDP, outpatient visits, inpatient discharges, enrolments and graduates at medical universities) do not change significantly by 2015. Because of the world economic crisis, whose effects started to influence the Serbian economy in 2009, we included a "pessimistic" scenario of GDP contraction (i.e. GDP 95% LCL) instead of the GDP central projections. Forecast outputs will differ from their consensus annual values by 2015, if identified predictors or the HRH planning approach significantly change the period 2011-15.

The Autoregressive Integrated Moving Average (ARIMA)/Transfer function (TF) time-series models [32] were the key statistical analysis and forecasting tools applied in this study. The ARIMA/TF procedure also includes an Expert Modeler component that identifies and estimates an appropriate model for each output variable series and predicts its values. The specification of the model also identifies outliers, i.e. non-standard values. Model stability, significance and fit have been tested with stationary-R2 and Ljung-Box statistics. Kolmogorov-Smirnov Z test has been used to verify normal distribution of residuals in the model. The statistical tool was IBM SPSS Statistics (ver. 20).[33]

Results
Physician and nurse deployment in the public healthcare sector of Serbia from 1961 to 1982, the number of employed physicians increased by 174%; the number of nurses by 282%, the population by 15%, GDP by 200%, the number of inpatient discharges by 132%, the number of outpatient visits 67%, the number of enrolments at the first year medical studies by 206%, and the number of graduated physicians by 114%. From 1961 to 1982, change in the employment of physicians was significantly related only to GDP change while
nurse employment
grew independently of changes in the independent variables. Both physician and nurse employment models were statistically stable without outliers and with a normal distribution of residuals (Table 3). The number of inpatient care discharges was related to the number of employed physicians and GDP, while the number of outpatient care visits was related only to the number of employed physicians.

Table 3
In the second period, from 1983 to 2008, the numbers of employed physicians and nurses increased by about 43% each. The population decreased by 6%, GDP by 50% and the number of outpatient visits by 11%. However, the number of inpatient discharges increased by 28%. Both the number of students enrolled in the first year medical studies and the number of graduated physicians decreased by 50%. Physicians employment correlated with population and GDP, while nurses to the number of employed physicians (Table 4). The physician-to-nurse ratio remained the same, 1:2. However, the population, GDP, inpatient care discharges and outpatient care visits were not significantly related to the number of enrolled students at the first year medical studies (x5) or graduated physicians (x6).

Table 4
In the second period, ARIMA/TF models of almost all input variables had outliers, with the exception of the model of outpatient care visits. The ARIMA (1, 2, 0) model of population size timeseries had 4 outliers: level shift in 1991 (t = -25.00; p < 0.01), additive in 2001 (t = 32.79; p < 0.01) and in 2002 (t = -38.18; p < 0.01), and local trend in 2005 (t = 10.31; p < 0.01). A decrease of population size was registered in 1991 and 2002, most likely because the techniques for the population census were different from those used for other years where there were mid-year estimates. Increases of the
population size in 2001 and 2005 perhaps reflected the pull effect of the national politics that changed in 2000, and then the economic reform that began the following year.

The physician employment model was statistically stable, without outliers and with a normal distribution of residuals (Figure 1). The nurse employment model was statistically stable, with two outliers, and with a normal distribution of residuals (Figure 2). The modelled non-standard values in the nurses’ employment model were: additive in 1995 ($t = -8.22; p < 0.01$) and level shift in 2005 ($t = -3.61; p < 0.01$). In 1995, the nursing staff was significantly reduced due to flexible retirement and beneficial disability pensions, ceased deployment, and in 2005 due to planned rationalization and early retirement schemes in the public healthcare sector.

The ARIMA (0, 2, 0) model of GDP time-series had one local trend outlier in 1994 ($t = 3.40; p < 0.01$), likely a result of currency reform after hyperinflation in 1993.

The model of inpatient care discharges had an additive outlier in 1999 ($t = -6.14; p < 0.01$), perhaps because of reduced financial resources (GDP was a predictor) and changed operational plans of institutions before and during the two and half-month long NATO bombing of Serbia (Figure 3).

The model of outpatient care visits had no outliers (Figure 4).

The innovation outlier recorded a decrease in the time-series model of enrolled medical students in 1985 ($t=-8.72; p < 0.01$), which could have been a sign of the influence of the second HRH strategy (Figure 5). The increased number of graduated physicians in 2008 ($t=2.84; p=0.01$) was another innovation outlier, recorded after adoption of the Bologna declaration that changed curricula and length of medical studies [25] (Figure 6).

Forecasting the physician and nurse supply for the public healthcare sector of
Serbia by 2015
According to our forecast, in 2015 there will be 1207 more physicians (or 5.86%) and 2459 more nurses (or 5.76%) employed in the public sector than in 2008 (Table 5). The physician and nurse rates per 100,000 of population will rise by 12.5% and by 12.8% respectively, i.e. from 272 to 306 for physicians and from 562 to 634 for nurses.

Table 5
With regard to annual forecasts, by 2015, the annual number of enrolments (1771) will be higher by about 20% than the current number of graduates at public medical faculties (1415). The annual workforce generation ratio [13], calculated as ratio of the number of physician graduates and the total number of physicians employed in public sector will be around 6.58% for every year in the forecast period. It will be far less than the new deployments of physicians per year, which is projected to be 0.7% on average. The sum of annual differences between the new supply of physician graduates and their deployments in public healthcare sector is therefore projected to be 8759 persons (9905 vs. 1207???).

Discussion
This study analysed the relationships found in six models that could be used for planning the physician and nurse requirements for the public healthcare of Serbia. The projections made use of over 50 years of data. Based on those models the number of physicians and nurses required in the public health care of Serbia (the supply) by 2015 were estimated. The analysis also pointed to a significant rise of physicians (specialists in particular) and nurses (but not the midwives) in the public sector of Serbia.

[23-25] This study has identified that the most significant predictors of physician and nurse staff for the last twenty-five years were GDP and population. That relationship between changes in the economy and in

[4-7]
physicians was an incentive for healthcare service utilization in general. Besides flexible retirement schemes, voluntary specializations, changes in the health institutions ownership and structure, other factors like piloting new health technology have affected the upward and downward workforce density slopes from time to time[24-25].
The constant increase of physician and nurse density suggest that access to healthcare and to education have been traditional social values in Serbia that could resist political and economic upheavals. This study provided evidence that enrolment and graduation rates at public medical faculties were self-directed, and that a relatively stable policy for the intake at public medical faculties (intake vary ±20%) will result each year in almost eight times the number of graduated physicians than the number of vacancies in the public healthcare sector. Responsive partnership between government-funded medical schools, healthcare sector and other health stakeholders is needed.[34,35] Health experts agree that addressing population health needs should be solved by doing more than creating more health workers.[34,35]
Given the tendency of Serbian health workers to emigrate [36], the return of investments in their education and fiscal income should be assessed. The country has spent US$ 9-12 billions on the education of physician specialists [37] (the lower sum corresponds to the total Serbian public debt in 2009[38]). The real financial losses would have been much higher if the calculation covered the total estimated 10,000 Serbian health professionals working abroad[37], lost profits, replacement costs and other indirect losses.
Study limitations
The time-series models in the study generated result that were reasonably similar to current
situation. There is no difference between forecasted and registered number of physicians and nurses (only 0.1% in 2011) in public healthcare sector. Thus the approach can be used for projecting future trends in Serbia. Shifts in in the macroeconomic contexts were dominant source of forecasting failures in this study. GDP growth rate in Serbia fell from 5.5% in 2008 to -3.0% in 2009 and to 1.8% - 2.0% growth in 2010.[38] The introduction of flexible retirement is also a (macro)economic intervention for staff reduction. [4,6,9,11] Indeed, about 3.9% of nurses left the public sector of Serbia due to more favourable terms for retirement introduced in 1995. Other authors also estimated a 3.5% difference between the forecast and registered number of health workers could occur solely by changing the conditions for retirement. [9] Due to an ageing workforce in Serbia, the introduction of prolongation regulations for age-related retirement may alternate the estimated overall outflow rate of 2-2.5% per year, and in turn the share of younger health workforce. Models are simplifications of the actual situation in Serbia, since they did not capture the growth of private practice, of private medical schools or health workforce migration. [12,16] Though the data are incomplete, it is expected that relatively large private sector will continue to grow (in one year the health professionals' authorities licensed 2,931 private physicians, and 800 nurses and health technicians while in the next year there were 3,093 private physicians and around 1000 nurses and health technicians).[39,40] Out of the total number of 30,500 licensed physicians and 64,000 nurses, almost 1,900, physicians and 2,900 nurses and health technicians are inactive.[39,40] Having complete and valid data on the number of private practitioners is difficult in almost all countries.[11,12,] In Serbia it is also a complex issue since publicly employed health workers are allowed to provide specialist, consultative and /or training services in the private sector and
as volunteers outside the public healthcare sector. Also the climate for private business is still unstable in Serbia. Each year, a large number of new private healthcare entities enter the economy while some disappear, transform or centers).[39].

Another limitation of the study was aggregated data. Earlier segregated analyses of health professionals showed upward density trends among specialists, nurses, and general practitioners, but not for college nurses, midwives, dentists and pharmacists.[24,25] The presence of other health professions (such as dentists, pharmacists, laboratory technicians, radiographers, physiotherapists etc) has not been described in this study. Their number grew in line with the expansion of the public health sector, particularly during the introduction of programmed healthcare and extension of guarantied healthcare benefit basket, in mid 1970s and in the beginning of 1980s. [24,25] Since they represent 21% of total health professionals in public sector now, and their skills are important, particularly in teams needed to provide specialized services, their relationship with physician and nurse staffing and ratio should be explored in future research.

Study implications for policy and practice

The future inter-sector HRH strategy and action plan should develop careful health development plans, goals and objectives. To deliver an inter-sectoral HRH strategy the government should commission a high-level and independent body to analyze and forecast dynamics of crosscutting problems regarding HRH production, employment and performance. The essence of its activity should be the harmonization of HRH-related policies in all sectors with the health development plan. Future research should estimate how many of the physicians would be employed in the private sector, and its effect in preventing future mismatches between demand
and supply of physicians in the emerging economic scenario.

Possible options to maintain health system efficiency with unrevised staffing plans include expansion of the user groups’ number and/or services and partnership with other HRH labor markets.

The WHO Global Code of Practice on the International Recruitment of Health Personnel should be implemented in order to strategically govern the mobilization and development of national HRH.

Conclusions

Though the increasing number of unemployed health professionals ensures that there will be an available supply in the future, it also makes Serbia another source country for well qualified health workers. The significant mismatch between forecast requirements of physicians and available posts should be used as pointer to decision-making on intake planning for the medical schools in Serbia.

Serbia needs an inter-sector strategy for HRH development that is more coherent with healthcare objectives and more accountable in terms of professional mobility.

The ARIMA-TF model may be used to improve understanding of the impact of the traditional HRH governance. The relative dimension, not the specific accuracy of the continued upward trend in numbers of physicians and nurses is important for Serbian HRH stakeholders. This study may serve for comparison with other forecasts of physician and nurse supply in Serbia whilst creating future HRH policies.

Conflicts of interest: None to declare.

Acknowledgements: The study had a general support from the Ministry of Science and Technology of the Republic of Serbia (Grant no.175087). Authors are grateful for professional support of prof. dr Snezana Simic (Medical Faculty University of Belgrade, Serbia).

Authors’ contributions: MSM, VV and JM conceived and designed the study and have made
substantial contributions to analysis and interpretation of data. MSM and VV collected data and drafted
the manuscript. All authors have given the final approval.

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Table 2. Public debt of Republic of Serbia in the period 2000 - January 2012

and role of the Serbian Medical Chamber. 18th Symposium of Central and East European Chambers of Physicians (zeva), Cracow, 2011.

40. Serbian Chamber of Nurses and Health Technicians, electronic data available at www.kmszts.org.rs.

Table 1. Districts with the highest and the lowest number of health workers in the public healthcare sector per 100,000 population in the Republic of Serbia


<table>
<thead>
<tr>
<th>Year</th>
<th>Districts with the highest number of health workforce (physical persons) per 100,000 population</th>
</tr>
</thead>
<tbody>
<tr>
<td>2005</td>
<td>Nisavski Belgrade Sremski Macvanski physician nurse physician nurse physician nurse</td>
</tr>
<tr>
<td>2006</td>
<td>Nisavski Belgrade Sremski Macvanski physician nurse physician nurse physician nurse</td>
</tr>
<tr>
<td>2007</td>
<td>Nisavski Belgrade Sremski Macvanski physician nurse physician nurse physician nurse</td>
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<tr>
<td>2008</td>
<td>Nisavski Belgrade Sremski Macvanski physician nurse physician nurse physician nurse</td>
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<tr>
<td>2009</td>
<td>Nisavski Belgrade Sremski Macvanski physician nurse physician nurse physician nurse</td>
</tr>
<tr>
<td>2010</td>
<td>Nisavski Belgrade Sremski Macvanski physician nurse physician nurse physician nurse</td>
</tr>
</tbody>
</table>

Table 2 Basic descriptive statistics of all variables in the study in the period 1961-2008

Table 3 Implicit description of all Transfer function models from the first period 1961-1982

Name Labels MAX MIN
Net change
y1 Number of physicians 20668 4618 3.24
y2 Number of nurses 42480 6422 4.10
x1 Population size number of inhabitants 7897937 6678239 0.20
x2 GDP value in real prices 48857 13662 2.75
x3 Number of inpatient care discharges (in thousands) 1214 379 2.51
x4 Number of outpatient care visits (in thousands) 50261 21849 1.20
x5 Number of students enrolled at the first year of medical
<table>
<thead>
<tr>
<th>Dependent variable (labels and name)</th>
<th>Potential predictors in Start model (only name)</th>
<th>Significant predictors in Final model (only name)</th>
<th>Model type</th>
<th>Stationary-R2</th>
<th>Number of outliers</th>
<th>Q-stat (p-value)</th>
<th>Z-stat (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Physicians</td>
<td>x1, x2, x3, x4, x2 TF(0,1,0)</td>
<td>y1, x1, x, x6 y1, x1, x6</td>
<td></td>
<td></td>
<td>1.52</td>
<td>0.81</td>
<td>0.63</td>
</tr>
<tr>
<td>x6 Number of graduated medical doctors (at public faculties)</td>
<td>1724 553 1.68</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>x5, x6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>y1, x1, x6</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nurses</td>
<td></td>
<td></td>
<td></td>
<td>4.67</td>
<td>0.93</td>
<td></td>
</tr>
</tbody>
</table>
x2, x3, none ARIMA(0,2,0) 0.76 1
(y2) (0.59) (0.35)
x4, x5, x6
Inpatient
y1, y2,
care 8.30 0.89
x1, x2, none ARIMA(0,1,0) 0.96 3
discharges (0.22) (0.40)
x4, x5, x6
(x3)
Outpatient y1, y2,
6.00 0.70
care visits x1, x2, y1 TF(0,1,0) 0.61 0
(0.42) (0.72)
x3, x4, x5, x6
Students y1, y2,
0.60 0.55
enrolled at x1, x2, x6 TF(0,1,0) 0.98 4
(0.99) (0.92)
the first x3, x4,
Legend: stationary R2 – measure goodness of fit of model. Range is from negative infinity to 1; Q-stat –
is Ljung-Box Q(6) statistics that test null hypotheses of no autocorrelation in residual series; Z-stat – is Kolmogorov-Smirnov statistics that test null hypotheses of normal distribution of residual series
year of studies
(x5)
x5, x6
Graduated medical doctors
(x6)
y1, y2,
x1, x2,
Table 4 Implicit description of all Transfer function models from the second period 1983-2008

<table>
<thead>
<tr>
<th>Dependent variable (labels and name)</th>
<th>Potential predictors in Start model (only name)</th>
<th>Significant predictors in Final model (only name)</th>
<th>Model type</th>
<th>Stationary-R2</th>
<th>Number of outliers</th>
<th>Q-stat (pvalue)</th>
<th>Z-stat (pvalue)</th>
<th>x1, x2, Physicians 5.35 0.63</th>
</tr>
</thead>
<tbody>
<tr>
<td>x3, x4, x5, x6</td>
<td>none ARIMA (0,1,0) 0.85 3 3.85 (0.70) 0.84 (0.48)</td>
<td></td>
<td>ARIMA</td>
<td>0.85 3 3.85</td>
<td>0.70</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x3, x4, x1, x2</td>
<td>TF(0,1,0)</td>
<td>0.71</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(y1)</td>
<td>(0.50)</td>
<td>(0.82)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x5, x6</td>
<td>y1, x1,</td>
<td>Nurses 7.34</td>
<td>0.53</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>x2, x3, y1</td>
<td>TF(0,1,0)</td>
<td>0.92</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>(y2)</td>
<td>(0.29)</td>
<td>(0.94)</td>
<td></td>
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</tr>
<tr>
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<tr>
<td>y1, y2,</td>
<td>care 7.34</td>
<td>0.51</td>
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<tr>
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<td>discharges</td>
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<td>x4, x5, x6</td>
<td>(x3)</td>
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<tr>
<td>Outpatient</td>
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<td>care visits</td>
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<td>TF(0,1,0)</td>
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<td>(0.88)</td>
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<tr>
<td>(x4) x3, x5, x6</td>
<td>Students y1, y2,</td>
<td></td>
<td></td>
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<tr>
<td>enrolled at</td>
<td>x1, x2, 4.97</td>
<td>0.67</td>
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<tr>
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<td>ARIMA(0,1,0)</td>
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<tr>
<td>the first</td>
<td>x3, x4, (0.55)</td>
<td>(0.77)</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>year of x5, x6</td>
<td></td>
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</tbody>
</table>

Legend: stationary R2 – measure goodness of fit of model. Range is from negative infinity to 1; Q-stat – is Ljung-Box Q(6) statistics that test null hypotheses of no autocorrelation in residual series; Z-stat – is Kolmogorov-Smirnov statistics that test null hypotheses of normal distribution of residual series studies (x5) Graduated medical doctors
Table 5 Forecasts with 95% confidence level and realized values of physicians and nurses' supply in the public sector of Serbia through 2015

<table>
<thead>
<tr>
<th>Year</th>
<th>Physicians</th>
<th>Nurses</th>
<th>Forecast value</th>
<th>Lower value of 95% CL</th>
<th>Upper value of 95% CL</th>
<th>Realised value</th>
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</thead>
<tbody>
<tr>
<td>2009</td>
<td>20983</td>
<td>20590</td>
<td>21376</td>
<td>20825</td>
<td>20708</td>
<td>20590</td>
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</tbody>
</table>
Figure 1. Observed and fitted number (with 95% LCL and UCL) of physicians employed in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015

Figure 2. Observed and fitted number (with 95% LCL and UCL) of nurses employed in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015

Figure 3. Observed and fitted number (with 95% LCL and UCL) of inpatient care discharges (000) in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015

Figure 4. Observed and fitted number (with 95% LCL and UCL) of outpatient care visits (000) in public healthcare sector of Serbia (1983-2008) and the forecast by the year 2015

Figure 5. Observed and fitted number (with 95% LCL and UCL) of students enrolled at the first year of medical studies at public faculties in Serbia (1983-2008) and the forecast by the year 2015

Figure 6. Observed and fitted number (with 95% LCL and UCL) of graduated medical doctors at public faculties in Serbia (1983-2008) and the forecast by the year 2015

Works Cited

58(4): 216-228.

**Level of interest:** An article whose findings are important to those with closely related research interests

**Quality of written English:** Not suitable for publication unless extensively edited

**Statistical review:** Yes, but I do not feel adequately qualified to assess the statistics.

**Declaration of competing interests:**

I declare that I have no competing interests