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Analysis of Urbanization Dynamics in Turkey's Provinces Based on "Production" and "Consumption" Cities Approach

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Abstract

In recent years, analysis of urbanization dynamics in Turkey at the provincial level has become more important. Given that, the paper aims to discuss urbanization trends at the NUTS 3 level. In this context, urbanization dynamics are analyzed by focusing on sectoral value-added shares in GDP and air quality data (PM10). The approaches related to the classification of the cities- either as a "production" or "consumption"- depending on cities' owning tradeable and non-tradeable sectors is considered. Accordingly, the urbanization dynamics of Turkey's provinces and to what extent environmental conditions differ would be investigated. The panel VAR (Vector Autoregressive Regression) analysis is used for the relevant data on the NUTS 3 level for the period of 2010-2020. The main findings indicate that the urbanization dynamics in Turkey's provinces cannot be explained only by the industrialization phenomenon. Urbanization occurs with different sectoral compositions additionally urbanization dynamics impacts services and construction sectors.

JEL Codes: O18, R11, C23

Keywords: Urbanization, Turkey's cities, production cities, consumption cities, environmental degradation and urbanization.

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Türkiye İllerinde Şehirleşme Dinamiklerinin "Üretim" ve "Tüketim" Şehirleri Yaklaşımına Göre Analizi

Öz

Son yıllarda Türkiye özelinde şehirleşme dinamiklerinin, iller düzeyinde analizi de önem kazanmıştır. Buradan hareketle çalışma, şehirleşme eğilimlerini NUTS 3 düzeyinde tartışılması amaçlanmaktadır. Bu kapsamda, özellikle GSYH sektörel katma değer payları ile hava kalitesi verisi (PM10) üzerinde durularak şehirleşme dinamikleri analiz edilmektedir. İlgili yazında bir şehrin "üretim" ya da "tüketim" temelli olarak tanımlanması, ticarete konu olan ve olmayan sektörlere sahip olması ile ilgili olarak açıklanmaktadır. Buna bağlı olarak, Türkiye illerinin şehirleşme dinamiklerinin, "üretim" ya da "tüketim" şehirleri olarak farklılık gösterip göstermediği, çevre koşullarının ne ölçüde farklılaştığı yanıtlanmaya çalışılmaktadır. Bu amaçla, 2010-2020 arası dönemde, ilgili verileri NUTS 3 düzeyinde sınamak amacı ile Panel VAR(Vektör Otoregresyon) analizi kullanılmıştır. Temel bulgular, Türkiye illerindeki şehirleşme dinamiklerinin sadece sanayileşme olgusuyla açıklanamayacağını göstermektedir. Şehirleşme, farklı sektörel kapsamlarla ortaya çıkmakta, ayrıca şehirleşme dinamikleri hizmet ve inşaat sektörlerini etkilemektedir.

Jel Kodları: O18, R11, C23

Anahtar kelimeler: Şehirleşme, Türkiye'nin şehirleri, üretim şehirleri, tüketim şehirleri, çevresel tahribat ve şehirleşme

1. Introduction

Investigating the dynamics of urbanization constitute an important part of economic development. Historically, the structural transformation from agriculture to non-agriculture sectors has accelerated urbanization in developed countries. While industrialization has been the key accelerator of urbanization, today, the dynamics of urbanization could be explained beyond these facts (Henderson, 2010). Urbanization can also proceed without growth (Glaeser & Kahn, 2004; Glaeser, 2014). Besides urbanization in developing countries could be a costly project. Rapid urbanization impedes sustainability and efficient use of the resources. Lack of infrastructure, motorization might cause urban sprawl (OECD, 2018). Moreover, economic growth dynamics have differentiated the urbanization dynamics. Empirical evidence has shown that while cities grow, the sectoral composition varies dramatically (Jedwab, Ianchovichina & Haslop, 2022). This fact also shapes urban employment and its sectoral decomposition. As a consequence of these, contrary to the common view that industrialization accelerates urbanization, cities' dynamics are discussed with different dimensions. Especially in the case of developing countries, industrialization is not a prerequisite for urbanization, rather, there may be conditions in which the development of service or non-tradable sectors is also decisive for urbanization. Urbanization could occur with de-industrialization or acceleration of non-manufacturing, non-tradable sectors (Gollin, Jedwab & Vollrath, 2016). Agglomeration (Glaeser, 2010) as one of the dynamics of cities', might concentrate on non-manufacturing sectors. Hence the analysis of the linkages between economic growth and urbanization based on "cities" development becomes even more important. In this context, new facts can be decisive in the classification of the development dynamics of cities. Due to these, new concepts and approaches based on empirical evidence are emerging in defining cities' growth dynamics. The conceptualization of cities as "consumption" and "production" is one of the approaches used in explaining these dynamics (Gollin et. al, 2016; Jedwab et. al, 2022). Cities of countries facing de-industrialization might continue to grow although their "production" cities lose their production capacity (Jedwab et.al, 2022:5). In these cases, agglomeration dynamics have different features. As it is pointed out (Rosen, 1979; Roback,1982; Glaeser et.al., 2001 cited by Jedwab et. al, 2022: 5) cities with better amenities attract residents that accept lower wages or higher rents to live there. Agglomeration in production cities relies on manufacturing and tradeable services. This growth pattern leads by countries' increased production capacity. In others, spending of the resource rents on urban goods and services led to consumption cities whose growth was driven by increased consumption capacity. Since manufactured goods and tradeable services- urban tradeable- are often imported, non-tradable services, urban non-tradable dominate their sectoral consumption. Consumption cities are defined as cities that increased consumption capacity rather than production capacity (Jedwab et.al, 2022:3). Also, according to these approaches, the export structure of the cities determines urbanization characteristics via employment share and resource rents. Cities with a higher share of natural resource exports also own characteristics of consumption cities (Gollin et.al, 2016; Jedwab et.al, 2022).

Following this path, we inspire from the approach of “production” and “consumption” cities. So, we aim to investigate Turkey’s cities’ (provinces) urbanization rate and sectoral composition interactions. Studies on Turkey’s urbanization dynamics commonly focus on urbanization and economic growth nexus in the context of Kuznetsian approaches (Grossman & Krueger, 1991). Additionally, interactions between urbanization, industrialization and CO2 emissions, based on the EKC (Environmental Kuznets Curve) have been commonly investigated at the national-level (Cetin, Ecevit & Yucel, 2018; Pata, 2018; Lise, 2006). Based on these studies the EKC framework is invalid for both the long and short term. Given empirical studies investigation of urbanization dynamics at the NUTS 3 level is limited. To our knowledge, Güçlü (2016) has investigated these interactions at the NUTS 3 level between 2008 and 2013 by using S02 (Sulphur Dioxide-air quality data) data as a sign of environmental degradation. Also, regional SO2 data is utilized for the provinces of Turkey to investigate the EKC hypothesis based on spatial analysis for the period of 2004-2020 (Karahasan & Pinar, 2022). Both of these studies indicate invalid EKC for provinces of Turkey.

However, the analysis of urbanization dynamics in Turkey has gained new dimensions with sustainable development goals, and new concepts become important in the classification of the urbanization dynamics of cities. The cost of urbanization and economic growth dynamics need to be investigated in detail. In the case of Turkey, the urbanization and economic growth process are costly, increasing CO2 emissions (Lise, 2006; Kocabas, 2013). The transition to low-carbon urbanization seems to be one of the obstacles to considering SDGs (Kocabas, 2013). Additionally, urbanization comes with poor air quality that harms the quality of life.

Considering the recent growth dynamics in Turkey, it is suggested to explore the dynamics of economic growth on the NUTS 3 level. The sectoral composition varies across the cities and economic growth comes with different structural transformation phases. Rather than setting up a direct link between the economic growth and urbanization rate, sectoral value-added share of the cities is taken into account. It is suggested that Turkey’s cities own different typologies so the “production” and “consumption” capacities interact with determinants of economic growth.

Our study is organized as follows: methodology and data are outlined in section 2. In section 3, Turkey’s cities' urbanization and sectoral composition linkages are investigated. In section 4, the interactions between the urbanization rate and non-agricultural sectors (manufacturing, service, construction) and PM10 are examined by implementing GMM-PVAR(Generalized Method of Moments Panel VAR) analysis. The results are summarized in the last section.

2. Methodology and Data

In our paper, the estimation of the interaction between urbanization and industrialization is the initial step. Given the theoretical approaches to urbanization with de-industrialization (Gollin et. al, 2016), the sectoral value-added share of manufacturing, service and construction is considered. It is suggested that for analyzing growth dynamics these sectors play critical roles in the determination of value-added and employment share. The relevant data is derived from TurkStat on the NUTS 3 level for the period 2004-2020. The other specific data, export share in GDP is calculated from export values and GDP in dollars for each province. Urbanization data in our sample is defined as population density; the average number of inhabitants per km2 of populated urban space. This data is calculated based on ADNKS (Address-based population register system) data and the area (km2) of the provinces from Turkstat. For our sample to examine the impact of urbanization, the “urbanization growth rate” is calculated.

The impact of urbanization on environmental degradation could be analyzed with several indicators, basically CO2 emissions and air pollution data (SO2, PM10). In our case at the NUTS 3 level, the availability and continuity of the relevant environmental degradation data are limited. In this case, PM10 (particulate matter) data that is relevantly announced by SDGs data (TurkStat), have continuity only for the period 2010-2020. PM10 data is identified with the target of clean cities (SDG Target 11.6). Given figures are collected by the Turkish Ministry of Environment and Urbanization, as a part of the national air pollution monitoring network. This data is defined as an alternative proxy to account for air pollution and the measurement of air quality. PM10 figures are used as a sign of air pollutants (unwanted chemicals) in the atmosphere. According to the World Health Organization (WHO), PM10 concentrations should not exceed 40 µg/m3 annual mean (WHO, 2005) for human health. Activities led by factories, power plants, incineration plants, construction, as well as natural sources such as fire and dust transport are defined as major sources of PM10 (Erdun et.al, 2015). Hence rapid urbanization is expected to have an impact on air pollutants.

It is possible to classify provinces according to specific characteristics (green cities, clean cities, industrial cities, megacities etc.). In this case, the overall mean value of manufacturing value added is taken as a proxy. The mean value of manufacturing value added is calculated as 13 percent of GDP. The provinces are classified accordingly; those above and below this mean value. It is suggested that higher manufacturing value added is a sign of production capacity and export capacity that relies on tradeable goods. When this ratio is below this average, the contribution of other sectors is more evident. Due to missing values, our sample comprise of 75 provinces (Batman, Mersin, Osmaniye, Samsun, Şırnak, Uşak).

We aim to estimate the dynamic relations between urbanization rate and manufacturing, service and construction and PM10 data (see Eq.1). Following the evidences on dynamics of economic growth in Turkey we include construction data separately to clarify and distinguish the effects of the construction sector. Moreover, this sector is accepted to be one of the key parameters to analyze the growth dynamics of consumption tendencies. Primarily we depict correlations between these parameters for the period of 2004-2020. Although environmental degradation data availability led us to estimate the sample only for the period of 2010-2020.

$$durban_{it} = f(dman_{it}, dservice_{it}, dconstruction_{it}, dPMO_{it}) \quad [1]$$

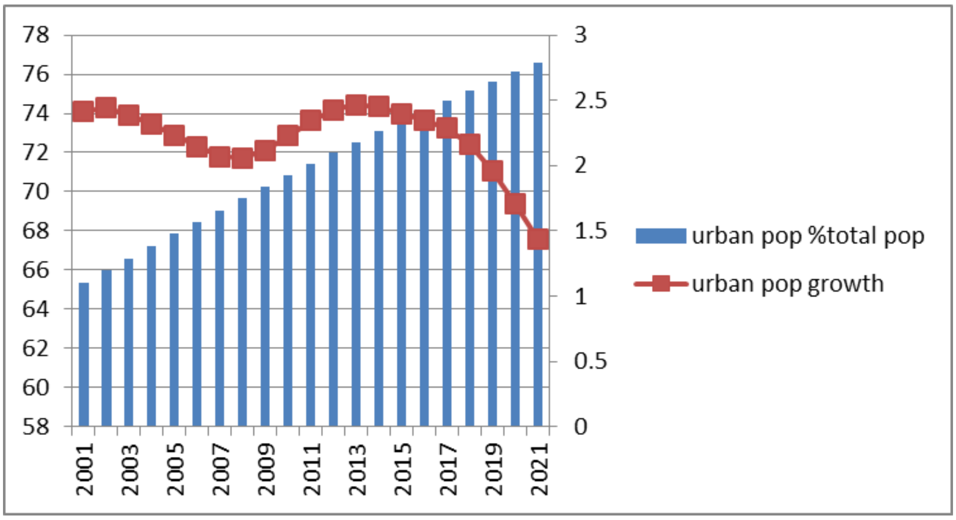
Our primary aim is to estimate the interaction among these variables empirically to discuss the urbanization characteristics depending on the typology of the cities and analyze the basis of urbanization and its costs. For this purpose, panel VAR model is utilized. Holtz-Eakin, Newey & Rosen (1988) constructed the panel vector autoregressive model (PVAR) that is similar to VAR models that include cross-sectional dimensions (Dogan Chishti, Alavijeh & Tzeremes, 2022). Later on, GMM PVAR is developed by Abrigo & Love (2016). PVAR model has some advantages such as overcoming the deficiencies of short time series data, providing more space for the data stability assumptions, and allowing the existence of unobserved individual heterogeneity and heteroscedasticity in the data (Lin & Zhu, 2017:783). This method can suitably eliminate the endogeneity problem. Estimation of The PVAR model is possible given the conditions of $T \geq 2L + 2$, and thus the model could be estimated under a steady state (Lin and Zhu, 2017:783). The GMM-PVAR model establishes a system of equations which includes all the variables as endogenous. Furthermore, it can capture the leverage of one exogenous shock by applying the orthogonalized response and keeping the other covariates invulnerable to external shocks (Abrigoa & Love, 2016; Sigmund & Ferstl, 2021). The model could be used to differentiate the transmission mechanism of given variables empirically, here in our case urbanization rate and value-added share of the relevant sectors and PM10 data. Impulse response analysis could be used to estimate the dynamic effects of one endogenous variable on other variables.

Our GMM-PVAR model is estimated accordingly based on theoretical and empirical evidence on urbanization and industrialization linkages. Hence, we order the parameters, primarily as urbanization rate later on manufacturing, service and construction value-added shares and finally PM10.

3 Turkey's Cities: Urbanization and Sectoral Composition Linkages

In the aftermath of the 2001 crisis, the per capita income level on province level has also increased. Despite this, empirical studies indicates that, as a general trend, income convergence between provinces is limited (Durusu-Ciftci & Nazlioğlu, 2019; Karaca, 2018) and the club convergence (Aksoy, Taştan & Kama, 2019) case is valid. The findings indicate that the income differences between the provinces are especially determined by the structural features (Durusu-Ciftci & Nazlıoğlu, 2019) and the income gaps between the west and the east provinces still maintain disparities. The growth dynamics in the 2000s brought along structural transformations based on provinces. In the studies conducted at the regional level, it is determined that the regional structural transformation forms vary, and the shifts from agriculture to services are more pronounced in terms of certain regions where de-industrialization and servitization occur simultaneously (Börü & Tahsin, 2022).

Figure 1: Urban Population and Urban Population Growth in Turkey.



Source: World Bank (2022).

Besides at the national level, the ratio of the population living in urban areas has been increasing since the 1990s. In the context of our study, the urban population growth has changed over two sub-periods. The urban population growth increased in the period between 2004-2007 and 2010-2015. After 2005 the urban population growth rate has decreasing tendency. Although, the phenomenon of urbanization alone is not explanatory of the increase in income level among the provinces, the conditions in which the structural features are determinant may be more decisive. It could be suggested that there is no strong correlation between the urbanization rate and the GDP per capita level of the provinces.

In provinces of Turkey, population density (in this case urbanization level) varies. The mean value of the urban population density growth rate is calculated as 0.9 (2004-2020) and 0.86(2010-2020). Istanbul has the highest values that are extremely different from the other provinces, whereas the average level of urban population density is 120 km2 for the relevant sample. According to universal definitions, urban clusters must have a population density of at least 300 people per square km2 (Our World in Data, 2022). Population density values indicate the scale of urbanization is limited in many provinces of Turkey.

Moreover, while focusing on sectoral decomposition and export share in GDP it could be suggested that the urbanization rate is not only explained by industrialization. Higher population densities do not come with higher manufacturing value-added shares. Urbanization also occurs depending on service sectors alone. The correlation matrix (Table 1) for the period of 2004-2020 indicates that the urbanization level is correlated both with the manufacturing and service sectors. Urbanization rate has only a positive correlation with service and construction value-added shares. The urbanization rate is negatively correlated with the export share of the provinces. There is a negative correlation between the manufacturing and service-construction sectors.

Table 1: Correlation Matrix (2004-2020).

	man	**service**	**construction**	**urbanization**	**export**	**urbanization rate**
man	1					
service	-0.6345*	1				
construction	-0.2882*	0.1022*	1			
urbanization	0.1752*	0.1216*		1		
exportshare	0.4642*	-0.0810*	-0.1380*	0.4191*	1	
urbanization rate		0.0528	0.0486		-0.0524	1

Source: Authors' Calculation.

Descriptive statistics are depicted for production cities (Table 2) and consumption cities (Table 3). Accordingly, apart from the differences in manufacturing value added share, our sample has the most fundamental difference related to the mean value of the service sector. For the consumption cities sample, this ratio is higher than the production cities sample. There are no significant differences in the data of PM10 and construction value added share. While manufacturing and service sectors have high standard deviations, the standard deviation for the construction sector value added share is relatively low. The mean value of urbanization growth rate, on the other hand, is higher in production cities. While it is (1.7) in production cities, the overall mean urbanization growth rate is lower (0.63) in consumption cities. Although for recent years lower tendency of PM10 level is measured, overall mean of PM10 data for both samples are above the WHO limit values that indicates poor quality of air. Eastern and Northern regions of Turkey have higher level of PM10 (Yildirim, Alpaslan & Eker, 2021).

Table 2: Descriptive Statistics for Production Cities Sample.

Variable		Mean	Std.dev.	Min	Max	Observation
man	overall	19.98817	8.202049	7.493792	41.87674	N = 429
Between			8.114397	10.02249	40.22531	n = 39
Within			1.722953	13.10129	28.40745	T = 11
service	overall	44.49885	6.786015	2.788126	60.33854	N = 429
Between			6.669616	3.120789	58.59216	n = 39
Within			1.614176	3.778311	52.67452	T = 11
construction	overall	6.033953	1.874416	1.841382	17.86283	N = 429
Between			1.410948	3.667966	9.998816	n = 39
Within			1.252666	1.787828	15.38428	T = 11
urbanization rate	overall	1.070301	1.730617	-9.5536	16.2774	N = 429
Between			0.754448	-0.4274164	29.74225	n = 39
Within			1.561776	-9.31354	16.80892	T = 11
Pm10	overall	57.31002	18.6809	19	115	N = 429
Between			12.82603	32.27273	79.81818	n = 39
Within			13.72271	14.91841	101.9464	T = 11

Source: Authors’ Calculation.

Table 3: Descriptive Statistics for Consumption Cities Sample.

Variable		Mean	Std.dev.	Min	Max	Observation
man	overall	5.476051	3.350315	0.6174169	17.29131	N = 396
Between			3.281042	0.959542	13.57104	n = 36
Within			0.855518	1.609044	9.196324	T = 11
service	overall	50.98871	5.49173	37.35436	66.41825	N = 396
Between			5.082547	39.20847	62.02564	n = 36
Within			2.231769	41.46112	58.10378	T = 11
construction	overall	7.541678	2.875754	2.619416	18.95888	N = 396
Between			2.382978	3.784223	15.18098	n = 36
Within			1.653826	2.565826	18.33345	T = 11
urbanization rate	overall	0.638079	2.311224	-1.386996	1.477276	N = 396
Between			0.829144	-1.352979	2.610745	n = 36
Within			2.161407	-1.415563	1.438752	T = 11
Pm10	overall	55.20202	2236169	12	135	N = 396
Between			1584144	2.745455	1.022727	n = 36
Within			1598272	-9.070707	1.203838	T = 11

Source: Authors’ Calculation.

4. Empirical Analysis on Urbanization and Sectoral Linkages

We have utilized the following steps for the estimation of the GMM-PVAR model: Firstly, we define the GMM-PVAR model (Equation 2), which implies the regression dynamic interlinkages among these variables. Equation (2) (y_{it}) represents 5 variables vector (manufacturing, service, construction, urbanization rate, PM10) and (i) represent provinces. Testing the stationary of the panel data is the pre-condition for estimating the PVAR model. For this purpose, unit root tests are utilized. Later on overidentification test is considered. Following that granger causality, variance decomposition and impulse response for all variables to shocks are figured out.

$$y_{it} = \beta_{it} + \sum^{p}_{j=1}\beta_j y_{t-j} + i_t + \varepsilon_{it} \qquad [2]$$

For estimation, it is important to check whether the time series that are used in PVAR, are cross-sectional dependent. Depending on whether the time series used in PVAR analysis is cross-section dependent or not, which unit test will be used will be selected. To detect whether time series are cross-section dependent or not, Pesaran's CD Test is utilized (Pesaran, 2004, Levin et.al, 2002). Under the null hypothesis of independence, CD ~ N(0,1), p values close to zero indicate that data are correlated across panel groups. Table 4 which can be seen below, displays the p-value of Pesaran's CD test for production and consumption cities' variables. The results indicate that there is enough evidence to reject the null hypothesis of cross-sectional independence for all variables except the first difference of PM10 variable in production cities. For this reason, the 1st generation unit root test is inappropriate to use for production and consumption cities' variables. Therefore, the 2nd generation unit root test which was put forward by Pesaran (2007), is used. In Pesaran's panel unit root test, the series is considered stationary when the CIPS statistic's absolute value is greater than the absolute value of critical values at the 95% confidence level. Pesaran's panel unit root test's CIPS statistics for production and consumption cities can be seen in Table 4. According to these results of production cities, while manufacturing, service and construction variable are not stationary at level, PM10 and urbanization variables are stationary at level. As can be seen from Table 4, all variables of production cities are stationary at their first difference. Due to the Pesaran panel unit root test's CIPS statistics for consumption cities that could be observed in Table 4, all of the variables except urbanization are not stationary at the level. Only the urbanization variable is stationary at the level. All of the variables are stationary at the first difference level in consumption cities. Because of stationary test results of production and consumption cities, all variable's first differences are used in PVAR analysis. Additionally, Woolridge test for autocorrelation is utilized for both samples. Accordingly, we reject the hypothesis that there is a serial correlation in the model for the first difference of the variables.

Table 4: Cross Sectional Dependence and Unit Root Tests of Production Cities and Consumption Cities.

	Production Cities				Consumption Cities			
	Pesaran CD Test (p value)		Pesaran Panel Unit Root Test with Cross Sectional Dependence (CIPS Statistic)		Pesaran CD Test (p value)		Pesaran Panel Unit Root Test with Cross Sectional Dependence (CIPS Statistic)	
Variables	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
Man	0	0	-1.787	-2.726*	0	0	-1.787	-3.250*
Service	0	0	-1.545	-2.904*	0	0	-1.934	-2.487*
Construction	0	0	-1.897	-2.934*	0	0	-1.885	-2.935*
PM10	0	0,056	-2.539*	-3.227*	0	0	-2.026	-2.517*
Urban	0	0	-3.471*	-4.554*	0	0	-2.928*	-4.292*

Source: Authors' Calculation.

Lütkepohl (2005) demonstrates the stability condition of the VAR model. According to this study, for the VAR model to be stable, all moduli of the companion matrix have to be strictly less than one. The stability condition state that the VAR model is invertible and has an infinite-order VMA representation. Ensuring this stability condition is necessary for the interpretation of the estimation results of IRFs and FEVDs (Abrigo & Love, 2016).

Table 5 which is depicted below, shows the eigenvalue stability conditions of production cities and consumption cities panel VAR. As it can be seen from Table 5, all the moduli are smaller than one. So, it can be alleged that both of the panel VAR models are stable. Figure 2 also displays graphs of the eigenvalue stability condition of production cities and consumption cities panel VAR. In both panel VAR models, the roots of the companion matrix are all inside the unit circles. Therefore, it can be asserted that the panel VAR models are stable.

Besides Hansen's J set overidentification test[1] results strengths the validity of the instruments. Following that Granger causality tests are used to know whether past values of a variable are effective to estimate another variable (Granger, 1969). For example, if past values of variable x can predict the values of another variable y, we can assert that x variable is "Granger Causes" of variable y. Panel VAR Granger causality Wald test is utilized to show the relationship between the variables. In this test, H_0 hypothesis is

[1] For both sample; Hansen's J chi2(288) = 0 (p = 1.000)

“excluded variable does not Grange cause equation variable”. H_1 hypothesis is “excluded variable Grange cause equation variable”.

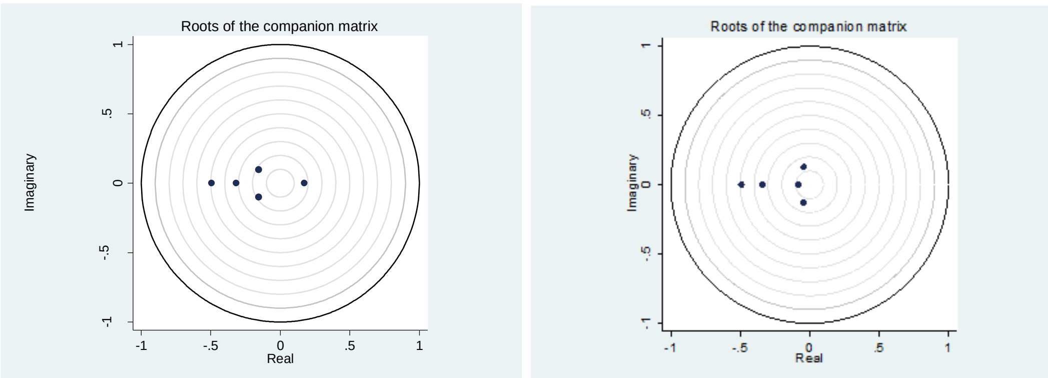
Table 5: Eigenvalue Stability Conditions of Production Cities and Consumption Cities Panel VAR

Eigenvalue		Modulus
Real	Imaginary	
-0.49405	0	0.49405
-0.31727	0	0.317274
-0.15691	0.098946	0.185499
-0.15691	-0.09895	0.185499
0.173376	0	0.173376
Eigenvalue Stability Condition of Production Cities		

Eigenvalue		Modulus
Real	Imaginary	
-0.49257	0	0.492566
-0.34299	0	0.342989
-0.04363	0.12825	0.135463
-0.04363	-0.128246	0.135463
-0.08234	0	0.082339
Eigenvalue Stability Condition of Consumption Cities		

Source: Authors’ Calculation.

Figure 2: Graph of Eigenvalue Stability Condition of Production Cities (Right Side) and Graph of Eigenvalue Stability Condition of Consumption Cities (Left Side)



Source: Authors’ Calculation.

Table 6 displays the panel VAR Granger causality Wald test results of production and consumption cities. According to production cities panel VAR Granger causality Wald test results, we reject H_0 hypothesis apart from only one relationship. This causality relationship is detected between construction and urbanization variables. Therefore, it can be alleged that the urbanization variable is granger cause of the construction variable. According to panel VAR Granger causality Wald test results of consumption cities we reject H_0 hypothesis for three relationships. The causality relationship is detected between; urbanization and service, PM10 and services, construction and manufacturing.

Table 6: Production Cities and Consumption Cities Panel VAR Granger Causality Wald Test Results

Panel VAR-Granger for Production and Consumption Cities					
Equation \ Excluded	chi2 and Prob > chi2 values				
durban					
	dman	**dservice**	**dcons**	**Dpm10**	**ALL**
Production	1.378	0.777	1.471	0.895	6.619
Prob > chi2	0.24	0.378	0.225	0.344	0.157
consumption	1.503	10.205	1.072	1.077	13.035
Prob > chi2	0.22	0.001*	0.3	0.299	0.011*
dman					
	durban	dservice	dcons	dpm10	ALL
production	2.231	0.005	0.262	3.414	7.508
Prob > chi2	0.135	0.941	0.608	0.065	0.111
consumption	0.48	2.715	0.441	0.528	3.425
Prob > chi2	0.489	0.099	0.507	0.468	0.489
dservice					
	durban	dman	dcons	dpm10	ALL
production	0.914	0.098	0.102	0.023	1.147
Prob > chi2	0.339	0.754	0.75	0.88	0.887
consumption	0.693	3.012	0.283	0.143	4.392
Prob > chi2	0.405	0.083	0.595	0.705	0.355
dconstruction					
	durban	dman	dservice	dpm10	ALL
production	4.343	3.352	0.105	0.094	3.4943
Prob > chi2	0.037*	0.067	0.745	0.759	0.041*
consumption	0.147	5.943	2.267	1.448	10.145
Prob > chi2	0.702	0.015*	0.132	0.229	0.038*
dpm10					
	durban	dman	dservice	dcons	ALL
production	2.343	1.875	0.054	0.01	3.617
Prob > chi2	0.126	0.171	0.816	0.921	0.46
consumption	0.004	0.286	6.274	0.018	9.073
Prob > chi2	0.949	0.593	0.012*	0.894	0.059
Prob>0.05					

Source: Authors' Calculation.

Table 7: Forecast Error Variance Decomposition of Production Cities

Response variable and forecast horizon					
	Impulse variable				
	dman	**dser**	**dcon**	**durban**	**dpm10**
dman					
0	0	0	0	0	0
1	1	0	0	0	0
2	0.988329	0.0020461	0.000521	0.0037551	0.008284
3	0.963226	0.0113718	0.007869	0.0059414	0.01322
4	0.95907	0.0116413	0.008128	0.006706	0.013321
5	0.956988	0.0123892	0.008915	0.0069102	0.013533
6	0.956493	0.0128965	0.008911	0.0069613	0.013528
7	0.956416	0.012941	0.008911	0.0069737	0.013529
8	0.956384	0.0129551	0.008915	0.0069768	0.013532
9	0.956376	0.0129574	0.008915	0.0069775	0.013536
10	0.956376	0.0129574	0.008915	0.0069777	0.013537
11	0.956376	0.0129574	0.008916	0.0069777	0.013537
12	0.956376	0.0129574	0.008916	0.0069778	0.013537
13	0.956376	0.0129574	0.008916	0.0069778	0.013537
14	0.956376	0.0129574	0.008916	0.0069778	0.013537
15	0.956376	0.0129574	0.008916	0.0069778	0.013537
dser					
0	0	0	0	0	0
1	0.111014	0.8889864	0	0	0
2	0.117166	0.8700305	0.004417	0.0012169	0.001212
3	0.121788	0.8609975	0.006505	0.0017539	0.003483
4	0.120551	0.8605996	0.006618	0.0019327	0.004505
5	0.120535	0.8597035	0.007077	0.0019811	0.004822
6	0.12047	0.8597503	0.007082	0.0019936	0.00484
7	0.120465	0.8597489	0.007081	0.0019968	0.00484
8	0.120465	0.8597342	0.007086	0.0019976	0.004843
9	0.120464	0.8597298	0.007087	0.0019978	0.004846
10	0.120464	0.859729	0.007087	0.0019978	0.004847
11	0.120464	0.859729	0.007087	0.0019978	0.004847
12	0.120464	0.859729	0.007087	0.0019978	0.004847
13	0.120464	0.859729	0.007087	0.0019978	0.004847

Table 7 (Cont.):

14	0.120464	0.859729	0.007087	0.0019978	0.004847
15	0.120464	0.859729	0.007087	0.0019978	0.004847
dcon					
0	0	0	0	0	0
1	0.042566	0.1239927	0.833442	0	0
2	0.040492	0.1480811	0.810537	0.0156718	0.000553
3	0.046555	0.1512947	0.783209	0.0174935	0.009394
4	0.046839	0.1508902	0.780997	0.0181485	0.009534
5	0.046867	0.1514995	0.78	0.0182973	0.009572
6	0.046869	0.1515102	0.779968	0.0183353	0.009591
7	0.046884	0.1515336	0.779901	0.0183445	0.009595
8	0.046884	0.1515414	0.779885	0.0183467	0.009598
9	0.046884	0.151541	0.779884	0.0183473	0.009599
10	0.046884	0.151541	0.779884	0.0183474	0.009599
11	0.046884	0.151541	0.779883	0.0183474	0.009599
12	0.046884	0.151541	0.779883	0.0183474	0.009599
13	0.046884	0.151541	0.779883	0.0183474	0.009599
14	0.046884	0.151541	0.779883	0.0183474	0.009599
15	0.046884	0.151541	0.779883	0.0183474	0.009599
durbanization					
0	0	0	0	0	0
1	0.006237	0.0039351	0.004926	0.9946205	0
2	0.030432	0.0128521	0.003345	0.9679239	0.004047
3	0.029528	0.0232526	0.003697	0.9589095	0.014063
4	0.034505	0.0353664	0.003827	0.9560264	0.016003
5	0.035946	0.0385074	0.00444	0.9552415	0.015955
6	0.035883	0.0389259	0.004839	0.9550348	0.016651
7	0.035935	0.0389509	0.004853	0.954982	0.016851
8	0.035958	0.0389498	0.004858	0.9549686	0.016854
9	0.035957	0.0389498	0.004861	0.9549654	0.016856
10	0.035958	0.0389498	0.004861	0.9549645	0.016857
11	0.035958	0.0389499	0.004861	0.9549643	0.016857
12	0.035958	0.0389499	0.004861	0.9549643	0.016857
13	0.035958	0.0389499	0.004861	0.9549643	0.016857
14	0.035958	0.0389499	0.004861	0.9549643	0.016857
15	0.035958	0.0389499	0.004861	0.9549643	0.016857

Table 7 (Cont.):

dpmo					
0	0	0	0	0	0
1	0.0001	0.007374	0.001895	0.0092819	0.990619
2	0.033167	0.0112895	0.001781	0.0112252	0.951579
3	0.033167	0.0143745	0.009435	0.0121664	0.931541
4	0.038123	0.0151883	0.009524	0.0123684	0.91868
5	0.038476	0.0153875	0.009535	0.0124103	0.917361
6	0.038717	0.0157082	0.009546	0.0124196	0.916803
7	0.038815	0.0158158	0.009563	0.0124218	0.916554
8	0.038813	0.0158392	0.009587	0.0124224	0.916498
9	0.038815	0.0158424	0.009588	0.0124225	0.91649
10	0.038815	0.0158424	0.009588	0.0124225	0.91649
11	0.038815	0.0158424	0.009588	0.0124225	0.916489
12	0.038815	0.0158424	0.009588	0.0124225	0.916489
13	0.038815	0.0158424	0.009588	0.0124225	0.916489
14	0.038815	0.0158424	0.009588	0.0124225	0.916489
15	0.038815	0.0158424	0.009588	0.0124225	0.916489

Source: Authors’ Calculation.

Forecast error variance decomposition analysis demonstrates the percent of the variation in one variable which is expressed by the shock to another variable. Forecast error variance decomposition analysis state the magnitude of the total effect. In this study, 10 years period is reported. If a longer time horizon would be used, it will produce similar results (Love & Zicchino, 2006). Table 7 presents the forecast error variance decomposition for production cities. According to these results, the manufacturing and service sectors' total growth rates explain approximately %3 - %3.8 of the change in urbanization growth rate in ten years period. The manufacturing sector growth accounts for approximately %12 of the variation in service sector growth in the same period. The manufacturing and service sectors' growth rates explain %4.6 (approximately) and % 15 (approximately) of the variation in the construction sector growth rate, respectively.

Table 8 reports the forecast error variance decomposition for consumption cities. Due to these results respectively construction sectors' growth rates explain approximately %3 and the service sectors’ growth rate explains approximately %4.6 of the change in urbanization growth rate on a ten-year horizon. The manufacturing sector's contribution to the urbanization growth rate is very little. Besides manufacturing sector’s growth rate explain approximately %3 of the service sectors’ growth. The service sector growth rate accounts for approximately %22 of the variation in the construction sector growth rate. The service sectors' growth rate explains %3.2 of the variation in the PM10 growth rate.

Table 8: Forecast Error Variance Decomposition of Consumption Cities

Response variable and forecast horizon					
	Impulse variable				
	dman	**dser**	**dcon**	**durbanization**	**dpm10**
dman					
0	0	0	0	0	0
1	1	0	0	0	0
2	0.986634	0.010915	0.00077	0.0002296	0.001451
3	0.984193	0.013154	0.00077	0.0004355	0.001448
4	0.983948	0.013302	0.000781	0.0005225	0.001447
5	0.983912	0.013306	0.000784	0.0005507	0.001448
6	0.983903	0.013305	0.000785	0.0005588	0.001448
7	0.983901	0.013306	0.000785	0.000561	0.001448
8	0.9839	0.013306	0.000785	0.0005616	0.001448
9	0.9839	0.013306	0.000785	0.0005617	0.001448
10	0.9839	0.013306	0.000785	0.0005618	0.001448
11	0.9839	0.013306	0.000785	0.0005618	0.001448
12	0.9839	0.013306	0.000785	0.0005618	0.001448
13	0.9839	0.013306	0.000785	0.0005618	0.001448
14	0.9839	0.013306	0.000785	0.0005618	0.001448
15	0.9839	0.013306	0.000785	0.0005618	0.001448
dser					
0	0	0	0	0	0
1	0.022053	0.977947	0	0	0
2	0.027665	0.969083	0.001606	0.0009324	0.000714
3	0.029233	0.966733	0.001809	0.0015081	0.000717
4	0.029396	0.96631	0.001838	0.0017315	0.000725
5	0.029413	0.966213	0.001845	0.0018031	0.000727
6	0.029415	0.966188	0.001846	0.0018238	0.000727
7	0.029415	0.966182	0.001847	0.0018294	0.000727
8	0.029415	0.96618	0.001847	0.0018309	0.000727
9	0.029415	0.96618	0.001847	0.0018313	0.000727
10	0.029415	0.96618	0.001847	0.0018314	0.000727
11	0.029415	0.96618	0.001847	0.0018314	0.000727
12	0.029415	0.96618	0.001847	0.0018314	0.000727
13	0.029415	0.96618	0.001847	0.0018314	0.000727
14	0.029415	0.96618	0.001847	0.0018314	0.000727
15	0.029415	0.96618	0.001847	0.0018314	0.000727

Table 8 (Cont.):

dcon					
0	0	0	0	0	0
1	0.000674	0.236027	0.763299	0	0
2	0.025821	0.227363	0.736634	0.0004101	0.009772
3	0.025946	0.227226	0.736067	0.0005575	0.010204
4	0.025944	0.22728	0.735984	0.000589	0.010203
5	0.025944	0.22729	0.735968	0.0005956	0.010203
6	0.025944	0.227291	0.735965	0.000597	0.010203
7	0.025944	0.227291	0.735965	0.0005973	0.010203
8	0.025944	0.227291	0.735965	0.0005974	0.010203
9	0.025944	0.227291	0.735965	0.0005974	0.010203
10	0.025944	0.227291	0.735965	0.0005974	0.010203
11	0.025944	0.227291	0.735965	0.0005974	0.010203
12	0.025944	0.227291	0.735965	0.0005974	0.010203
13	0.025944	0.227291	0.735965	0.0005974	0.010203
14	0.025944	0.227291	0.735965	0.0005974	0.010203
15	0.025944	0.227291	0.735965	0.0005974	0.010203
durbanization					
0	0	0	0	0	0
1	8.8E-06	0.002138	0.019271	0.9785827	0
2	0.006245	0.028983	0.028558	0.9343006	0.001913
3	0.007136	0.041161	0.029732	0.9188486	0.003123
4	0.007179	0.045026	0.029897	0.9144543	0.003444
5	0.007171	0.046148	0.029926	0.9132353	0.003519
6	0.007167	0.046458	0.029932	0.9129059	0.003538
7	0.007166	0.04654	0.029933	0.9128196	0.003542
8	0.007166	0.046561	0.029933	0.9127973	0.003543
9	0.007166	0.046566	0.029933	0.9127918	0.003543
10	0.007166	0.046567	0.029933	0.9127904	0.003544
11	0.007166	0.046568	0.029933	0.9127901	0.003544
12	0.007166	0.046568	0.029933	0.9127901	0.003544
13	0.007166	0.046568	0.029933	0.9127901	0.003544
14	0.007166	0.046568	0.029933	0.9127901	0.003544
15	0.007166	0.046568	0.029933	0.9127901	0.003544

Table 8 (Cont.):

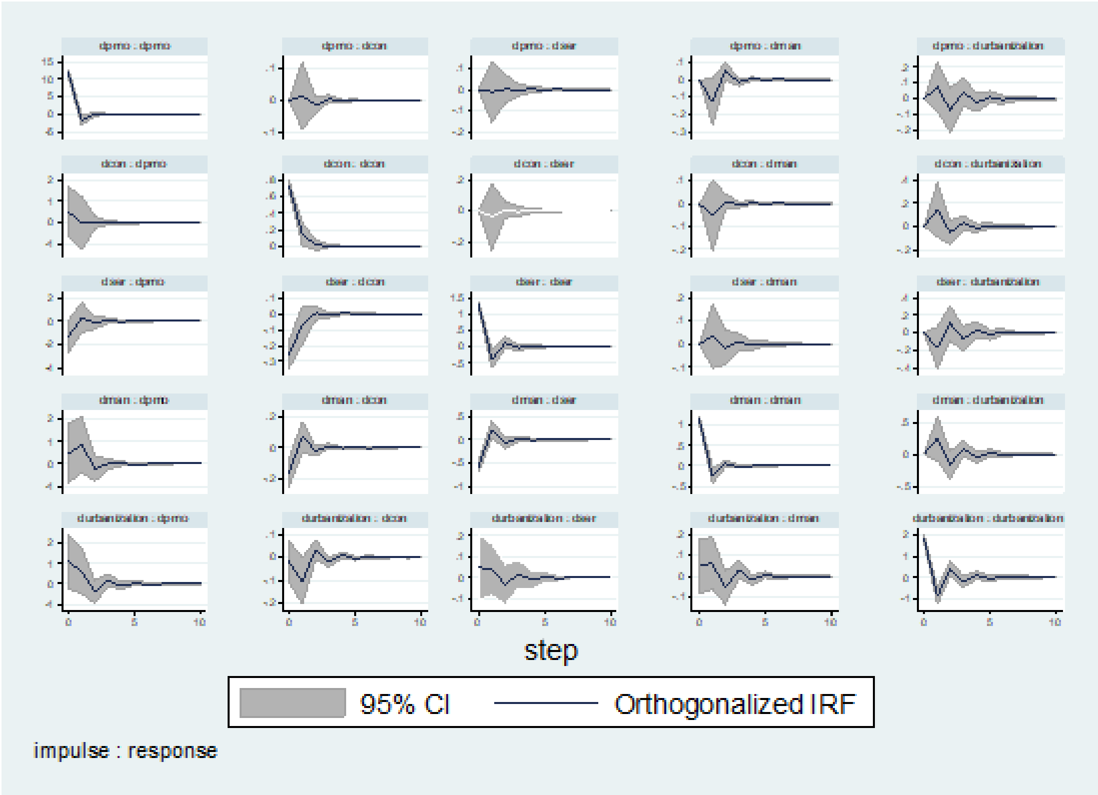
dpmo					
0	0	0	0	0	0
1	0.008887	0.003808	0.00131	0.0002807	0.985716
2	0.01159	0.029829	0.001313	0.0002747	0.956993
3	0.011649	0.031976	0.001358	0.0003131	0.954704
4	0.011699	0.032095	0.001366	0.0003351	0.954504
5	0.011705	0.032102	0.001367	0.0003432	0.954483
6	0.011706	0.032102	0.001368	0.0003458	0.954479
7	0.011706	0.032102	0.001368	0.0003465	0.954478
8	0.011706	0.032102	0.001368	0.0003467	0.954478
9	0.011706	0.032102	0.001368	0.0003467	0.954478
10	0.011706	0.032102	0.001368	0.0003468	0.954478
11	0.011706	0.032102	0.001368	0.0003468	0.954478
12	0.011706	0.032102	0.001368	0.0003468	0.954478
13	0.011706	0.032102	0.001368	0.0003468	0.954478
14	0.011706	0.032102	0.001368	0.0003468	0.954478
15	0.011706	0.032102	0.001368	0.0003468	0.954478

Source: Authors' Calculation.

The impulse response function defines the impact of a standard error change of random disturbance term on the current and future levels of the other covariates. The impulse response function analysis is a useful tool to investigate the dynamic relationship between variables (Lin & Zhu, 2017). The impulse response function confidence intervals which can be seen below in Figure 3 and Figure 4, are computed by 200 Monte Carlo draws.

The impulse response function for production cities is depicted in Figure 3. Row 1 of Figure 3 displays the effects of one standard error shock of other variables to PM10. Specifically, the shocks which are caused by manufacturing and urbanization have a fluctuating effect on PM10. In Row 2 the impact engendered by urbanization has a fluctuating effect on construction. In Row 3 of Figure 3. shock in PM10 and construction increase services. The shocks which are caused by urbanization and manufacturing, have a fluctuating effect on services. In Row 4 of Figure 3 the shocks that are produced by urbanization and PM10, have a fluctuating effect on manufacturing. The reaction of manufacturing to shocks in construction and services is positive. Finally, the shocks which are caused by PM10, service and manufacturing, have a fluctuating effect on urbanization. In this sample, the influence of manufacturing and service sectors on urbanization is more apparent.

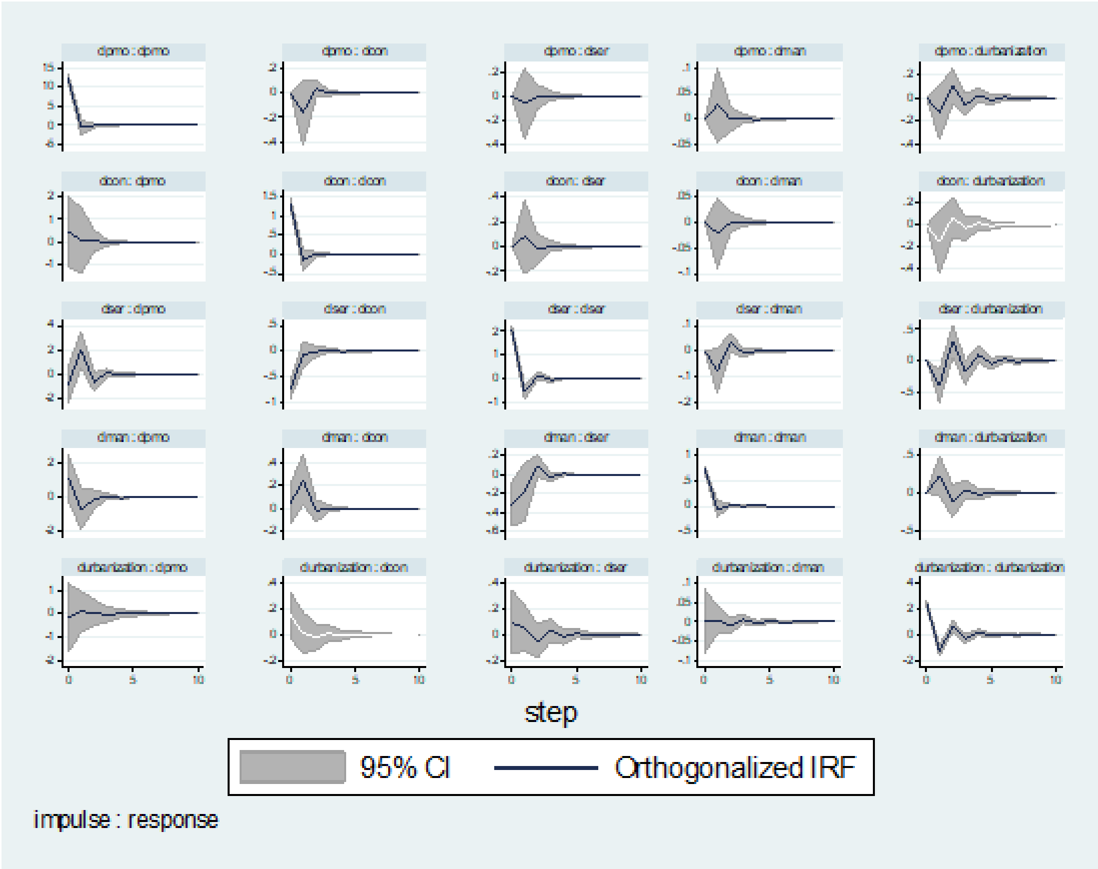
Figure 3: Impulse Response Function for 10 Years Periods -Production Cities



Source: Authors' Calculation.

The impulse response function for consumption cities is depicted in Figure 4. Row 1 of Figure 4 represents the effect of one standard error shock on other variables to PM10. PM10 shows first negative and then positive responses to a standard deviation in construction and services. The shocks that are produced by urbanization have a fluctuating impact on PM10. In Row 2 of Figure 4 shock in PM10 causes a reduction in construction. The shocks which are caused by urbanization, have a fluctuating effect on construction. The response of construction to shock on service is first positive and then negative. In Row 3 of Figure 4. shock in urbanization; have a fluctuating impact on services. According to Row 4, the shocks that are created by urbanization, have a fluctuating effect on manufacturing. The response of manufacturing to shock on construction and service is first positive and then negative. Oppositely the reaction of manufacturing to shock on PM10 is first negative and then positive. In Row 5 of Figure 4. while the shocks that are produced by service, have a fluctuating effect on urbanization; the shocks which are created by PM10, and manufacturing, have little impact on urbanization. Shock in construction reduces urbanization.

Figure 4: Impulse Response Function for 10 Years Periods - Consumption Cities



Source: Authors' Calculation.

5. Conclusion

In our paper, the interactions between the urbanization rate and sectoral value added shares and their connection with PM10 data at the provincial level are estimated by implementing the GMM-PVAR method. The findings indicate that the urbanization dynamics in Turkey's provinces cannot be explained only by the industrialization phenomenon. Even urbanization with de-industrialization is relevant for our case. The results of the samples led us to focus on the consequences of shifting from manufacturing to other non-agricultural sectors that could be harmful. Under these circumstances, the production capacities of the provinces seem to be limited. Urbanization occurs with different sectoral compositions additionally urbanization dynamics impacts services and construction sectors as well. In the case of our production cities sample manufacturing and service sectors simultaneously determine urbanization. At the same time, a higher urbanization rate accelerates the construction sector. It is possible to suggest that for the production cities sample, non-manufacturing sectors are also relevant and detrimental in explaining urbanization dynamics.

In the case of consumption cities, where the value-added share of the manufacturing sector is relatively low, urbanization is led by the service sector. At the same time, unlike the production cities sample, it is noteworthy that the service sector is detrimental for PM10 data. However, the findings do not provide a strong basis that PM10 data is directly related to urbanization. Our GMM-PVAR estimations assert that the dynamics of the urbanization level at the provincial level are mostly related to the non-manufacturing sectors. Urbanization dynamics tend increasing consumption capacity. Employment conditions, wage premium differences and urban sprawl effects need to be investigated in detail. Considering the SDGs and policy-making processes related to SDGs, the growth dynamics and policy-making process for targets of SDGs are thought to be contradictory.

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