The Effects of Structural Change on Economic Growth: A Panel Data Analysis

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Abstract

This paper attempts to enhance empirical understanding of the effects of structural-change variables on economic outcomes. The relationships between sectoral shares and (1) the speed of structural change and (2) economic growth were examined for a large panel of 111 economies over the period of 1971–2018. Given the time series properties of the series and the absence of a long-run relationship between them, the panel OLS and VAR models were employed. The results are largely in line with previous empirical research: it was established that a lack of industrialisation effort (manifested in the persistence of agriculture as a share of GDP) and 'servicisation' (the expansion of the services share of GDP) negatively affect GDP growth rates. In contrast, a growth in industry and manufacturing shares positively influences economic growth, as does accelerated structural transformation (represented by the respective index of structural change).

Keywords: industrial structure; structural change; panel data models

JEL Classification: L16; C33; O14; O57

Introduction

This paper concerns the effects of structural change on economic performance in developed, developing, and transition economies. There are several potential variations in formal definitions of structural economic change. In general terms, however, it involves a change in the relative size and growth of individual sectors and the pace of reallocation of labour, capital, and other resources across sectors – more specifically, changes in the structure of production, trade and investment, sectoral employment, and the allocation of resources across the economy (Hollis Chenery 1979). Broader socio-economic transformation (for instance, over the course of the development process) is by no means restricted to the economic realm, with changes in economic structure accompanied by political transformation, institutional change, and demographic shifts. Likewise, the effects of structural change are not limited to income and productivity growth, but also include poverty reduction and rises in levels of human capital, amongst other manifestations.

The purpose of this paper is to examine the effects on GDP growth of variations in sectoral shares and speed of structural change, for a panel of 111 economies over the period of 1971–2018. We specify an augmented aggregate production function that includes – alongside the usual regressors – the sector's share of GDP or, alternatively, a measure of structural-change speed. We focus on four shares (industry, manufacturing, agriculture, and services) and use the modified Lilien index of the structural change. Due to the nature of the data, the panel econometric methods are applied (panel unit root and cointegration), as well as panel OLS and vector autoregression (PVAR).

The remainder of the paper is organised as follows. Section 2 reviews the structural-change and growth literature and the theoretical and empirical aspects of the problem. Section 3 discusses the methodology (the model specification, data sources, and econometric techniques used in the paper). Section 4 presents the empirical results, including the basic specification and robustness checks. Section 5 presents the concluding remarks.

Literature review

As far as the 'economic structure–economic growth' nexus is concerned, the following categories of research are noteworthy. The first research category concerns the mechanics and effects of structural change. William Lewis (1954), Edward Denison (1967), and Bart Van Ark and Marcel Timmer (2003) have demonstrated the positive effects of productivity-enhancing structural change: the reallocation of labour and capital from low-productivity sectors to high-productivity alternatives (e.g., from subsistence to modern mechanised agriculture, or from agriculture to manufacturing), so that economy-wide productivity rises as a result. Denison (1967), for instance, attributes the superior economic performance of the United States relative to the United Kingdom in the 1950s to a faster pace of structural reallocation, while Shenggen Fan et al. (2003) and Khuong Vu (2017) established similar positive structural effects in the case of Chinese and Asian economic growth. The positive effects of structural re-allocations are by no means guaranteed (Margaret McMillan et al. 2014). William Baumol et al. (1989) point to a substantial diversity of productivity levels across industries and note that reallocations from high-productivity to low-productivity industries (sectors) will be growth-retarding, as is the case with certain low-productivity services. Nicholas Kaldor (1966) stresses the importance of available labour in the low-productive sectors: once labour has been fully or substantially transferred from such sectors, structural change will slow down (as was the case in the inferior economic performance of the United Kingdom in the 20th century, when it reached economic maturity ahead of other developed economies). The configuration of industrial relations, the structure of the political institutions, the backwardness of educational institutions, and the slack in the innovation systems may also result in the structural change not resulting in higher productivity (thus, the pervasiveness of structural change that is not limited to the economic realm – the co-evolution between economic, political, and social change – facilitates the positive effects on growth [Simon Kuznets 1971: 333–47]).

Second, a related group of studies attempts to determine whether structural changes matter for economic growth at all and whether causality runs from the former to the latter or vice versa. Neoclassical and endogenous growth theories relate growth to capital accumulation, productivity improvements, and innovation, but not to structural change *per se* (Robert Solow 1956; Robert Lucas 1988). Whenever structural factors are incorporated into the analysis (Jurgen Meckl 2002), the structural change is seen as an outcome or by-product of the growth, but not the determinant. The specific mechanism that underlies 'growth to structural change' causation involves adjustments in demand for goods and labour inputs (Luigi Pasinetti 1981; Piyabha Kongsamut et al. 2001; Andreas Dietrich 2012: 917). According to Engel's law, the low elasticity of demand for agricultural products and high elasticities for that of manufactured goods means that an increase in income stimulates faster growth of manufacturing industries than of primary industries (Kuznets 1971). Economic growth and an increase in income alters the demand for products in different sectors and induces production and structural changes. Likewise, the differential rates of technological progress in sectors and industries will alter the labour input requirements in production and similarly induce labour reallocations and structural change. The reverse causation from structural change to growth or co-evolution between the two processes has also been postulated (Baumol 1967; Pier Saviotti and Andreas Pyka 2008). Rising income alters the supply of labour and productivity gains (or losses) across the sectors and respectively the sectoral and aggregate growth rates. In a more complex relationship, a certain level of structural change is a prerequisite for economic growth (e.g., the minimum size of industrial sector to accelerate growth rates), while sustained growth subsequently causes both demand and structural changes. The dominant type of causation has been an empirical matter (Michael Stamer 1998; Karl Aiginger 2001; Cristina Echevarria 1997; Dietrich 2012).

Third, the contribution of particular sectors to economic growth has been examined. Development economists of the post-WWII era saw industrialisation as an engine of growth (e.g., Kaldor 1966; Lewis 1977; Anthony Thirlwall 1982). They emphasised the unique role of manufacturing in 'pulling along' aggregate economic growth and the positive effects of this sector: the strength and the extent of backward and forward linkages with other sectors and industries; the dynamic scale of economies, whereby the higher the growth of manufacturing productivity the higher the growth of manufacturing output; the technological changes that are more intensive in manufacturing than in the rest of the economy; the higher income elasticity and tradability that alleviates the balance-of-payments constraint, which is a salient feature in the growth of developing economies (Fiona Tregenna 2009: 436). In an economy characterised by circular and cumulative causation (where economic changes originating for a particular sector induce additional changes that push the whole economic system away from the equilibrium), the growth of manufacturing output induces productivity gains that reduce unit labour costs and prices, thereby increasing the competitiveness of the economy as a whole, in turn increasing output and exports ('Verdoorn's law'). These processes are cumulative: once the growth and comparative advantage in manufacturing has been gained (through learning by doing, induced technological change, and increasing returns to scale), the economy maintains and perpetuates them (Gilberto Libanio and Sueli Moro 2011: 2–3). The rise of the services sector, according to this view, is growth-retarding, while industry and manufacturing are growth-promoting and -accelerating.

With regard to the role of the services sector, the actual growth effects depend on the particular type of services sector. According to Bacon-Eltis, the expansion of the public sector is detrimental to growth. The government's expenditure bias towards the services and away from industry support, coupled with a reduction in industrial investment and upward wage pressure by trade unions, puts the manufacturing sector under pressure and reduces overall productivity (Robert Bacon and Walter Eltis 1976; Mohammed Ansari 1994: 244–5). In more general terms, the re-allocation of labour to the low-productivity services sectors (or even stagnant services – e.g., arts and education) has similar negative effects on overall productivity: higher productivity and consequent wage increases in manufacturing and industry put pressure on wages in the services sector and increase costs in services ('Baumol's cost disease'); in turn, higher wages in services channels labour forces in this sector and, given the low productivity of services, reduces overall productivity and growth (Baumol 1967: 419-20). On the other hand, Herbert Grubel and Michael Walker (1989) note the positive effects of high-productivity services, using a logic similar to that of Kaldor. While consumer and government services are characterised by lower productivity, production services that are human-capital-intensive (such as professional, scientific, and technical services) are the source of innovation in the economy and are instrumental in fostering productivity, reducing costs in other sectors, and promoting exports.

Empirical research on the 'structural change–economic growth' nexus tends to focus on two related issues: the relationships between the changes in sectoral shares and growth and between the speed (pace) of structural change and growth. The analysis considered the causal relationships between the variables, as well as the contribution of the structural variables to growth.[i]

The earliest empirical study by Ansari (1992) examined the deindustrialisation and servicisation processes in Canada during the period of 1961–1981, using quarterly data. The Cobb–Douglas aggregate production function augmented by the growth rates of industry and manufacturing (and their shares in GDP) was specified, and the OLS, GLS, and Almon models with distributed lags were estimated. The results unequivocally showed the negative consequences of deindustrialisation for Canada's growth. A later study by Ansari (1994) attributed the expansion of services in Canada during 1961–1990 to the expansion of government services, confirming the earlier hypothesis of Bacon and Eltis. Some reverse causality from total services to government services was also demonstrated. Echevarria (1997) demonstrated a non-linear relationship between sectoral structure and economic growth. The least developed countries with dominant agricultural sectors tended to have the lowest growth rates, while high-income economies with substantial services sectors had the high growth rates. However, the highest growth rate was observed in the high-middle-income group of economies (those with substantial manufacturing sectorgrowing services sector), indirectly implying a positive effect of manufacturing on growth.

Another group of studies looked at the effects of the structural-change process (Dietrich 2012: 918). According to Aiginger (2001), in a panel of 24 economies (in

Europe, the United States, and Japan) in the period of 1985–1999, structural change – as measured by the norm of absolute values (NAV) index – had a strong effect on growth, while reverse causality was substantially weaker. Stamer (1998) demonstrated a more complex chain of effects in West Germany during the period of 1970–1993. There was a bivariate causality between growth and structural change (measured by the modified Lilien index), albeit the latter had stronger effects on the former. In addition, while growth did accelerate structural change, structural change tended to slow down growth over time. Dietrich (2012: 919) observed a heterogeneity in effects that depended on how the structural change was measured (in terms of value added or employment). In the short run, growth slowed down structural change, but in the long run accelerated it. When the reverse effect of structural change on growth is considered, the effects were non-negative in both the short- and the long-run. Zulkhibri et al. (2015) considered four countries (Malaysia, Nigeria, Turkey, and Indonesia) over the period of 1960–2010 and estimated the modified Lilien and norm of absolute value (NAV) indexes of structural change. Panel cointegration and the DOLS model were applied. Cointegration between economic growth and structural change was indicated, though the effects of the latter on the former were small. In contrast, the effects of GDP on structural change were substantial, thus providing support for the 'induced structural change' hypothesis, which states that higher growth brings higher incomes and changes the demand structure.

A number of more recent studies have identified negative effects of structural change on growth. In African economies, the negative effect of a structural shift towards manufacturing was explained by the natural resource-focus of economies and resultant Dutch disease (Clemens Breisinger et al. 2014). In a related vein, Hartwig (2012), in the study that applied panel Granger causality tests to the data from 21 OECD economies, established negative effects on growth of services expansion (a key feature of structural change in developed economies). Margaret McMillan et al. (2014) confirmed the growth-reducing effects of structural change in Latin America, where trade liberalisation improved productivity of the top-performing firms in manufacturing and industry but contributed to labour shedding, the expansion of the informal sector and services, and (ultimately) slower economic growth. Finally, the positive effects of structural change, when present, were not time-invariant: Orcan Cortuk and Nirvikar Singh (2011), for instance, identified positive effects on Indian growth, only in one of the sub-periods.

Thus, the empirical findings are inconclusive and consideration of a larger group of economies and use of more up-to date econometric methods are required. The present empirical study differs from the past research in a number of respects. First, it includes more alternative estimates (including sectoral shares and structural change indexes). This contrasts with the study by Muhamed Zulkhibri et al. (2015), for instance, that was limited in scope to structural change indexes, and with the investigation by Aurora Teixeira and Anabela Queiros (2016) that proxied structural change by the share of employment in knowledge-intensive industries to total employment. Second, to provide more complete results, this study covers the largest possible panel (composed of 111 countries) and sub-divides these into three sub-panels based on the level of aggregate income per capita. This differs from the study by Zulkhibri et al. (2015), which focused on just four countries, that of Khuong Vu (2017) that included 19 Asian economies, and the work of Teixeira and Queiros (2016) that provided estimates for 21 OECD and nine Eastern European and Mediterranean countries. Third, it employs a wide range of up-to-date techniques: panel data OLS with and without fixed effects and the (dynamic) common correlated effects models that are suited for cross-sectionally dependent data (as verified by the respective tests). Owing to the stationarity of the data, this study also used the panel vector autoregressive (PVAR) model, which included a number of specifications – multivariate, bivariate, with alternative lag orders, and alternative proxies of the variables. In contrast, previous studies have tended to rely on a single method. This has included GDP growth-decomposition to identify structural changes (Shenggen Fan et al. 2003) and the application of generalised methods of moments (Teixeira, Queiros 2016; Vu 2017) and panel dynamic OLS (Zulkhibri et al. 2015) for GDP growth regression.

Methodology

Model

This study considers two related issues: the effects of individual sector shares (agriculture, services, industry and manufacturing), as well as the effect of the pace of structural change on the economic growth.

The former aspect is modelled based on the specification proposed by Ansari (1992: 1237). The standard Cobb-Douglas production function $Y = e^h K^\alpha L^\beta$ with capital (K) and labour (L) inputs is linearised via a log transformation and is differentiated with respect to time so that respective coefficients represent elasticities of output with respect to labour and capital as follows:

$$\ln Y = h + \alpha \ln K + \beta \ln L \tag{1}$$

$$\frac{d \ln Y}{dt} = h + \alpha \frac{dK}{dt} \cdot \frac{1}{K} + \beta \frac{dL}{dt} \cdot \frac{1}{L} \tag{2}$$

,where α and β are respective elasticities, t is time, and h is a constant that represents productivity effects of Hicks-neutral technological change. The model is further augmented by the sectoral share and external driver of growth and represented in growth terms as:

$$\dot{Y}_t = c + \alpha \dot{K}_t + \beta \dot{L}_t + \gamma \dot{S}_t + \varphi \dot{X}_t + \varepsilon_t \tag{3}$$

,where $\dot{Y}_t$, K_t, $\dot{L}_t$, $\dot{S}_t$ and $\dot{X}_t$ are the growth rates of GDP, gross fixed capital formation (GFCF), labour force, sectoral share and exports, and ε_t is an error term. As part of alternative specification and robustness checks, we include alternative variables (investment share of GDP instead of GFCF, and openness as a ratio of the sum of export and imports to GDP instead of aggregate exports) and also experimented with bivariate specification or model without external economic determinants; this however does not alter the size of coefficients (only in the case of openness measure the statistical significance of the coefficients and model as a whole decreases). The specific purpose of the paper is to examine the effects of changes of the sectoral shares on growth, as opposed to the effects of sectoral growth rates on the growth, hence this latter aspect examined by Ansari (1992), is not examined in this paper.

With regard to the pace of the structural change effects, the same model in growth terms is used, but the sectoral share is replaced with the measure of the structural change. This study employs modified Lilien (MLIL) index to measure the speed of structural change in the respective economies (Stamer 1998; Dietrich 2012: 921; Zulkhibri et al. 2015: 103).

MLIL is superior to other structural change measures (specifically, norm of absolute value/ NAV, and unmodified Lilien indexes) in a number of respects. The NAV index takes the differences between the sector shares in absolute terms between two time points, sums them and divides by two to achieve standardisation of the results (since each change is accounted twice). It, however, does not discriminate between large-scale reallocations occur in few sectors as well as fewer reallocations in many sectors, and hence may indicate same or similar pace of structural change.

Likewise, while David Lilien (1982) index is superior to NAV in that it calculates the standard deviation of the sectoral growth rates, without modification that is implemented for MLIL, the Lilien index is not invariant to the direction of structural change (i.e. the index depends not only on the amount of changes, but also whether change is measured from s to t or from t to s). The unmodified Lilien index also violates triangle inequality, $SC_{s,t} \leq SC_{s,q} + SC_{q,t}$ for $s < q < t$ where SC indicates structural change (the structural change during the period may at time be greater than the sum of structural changes during the sub-periods, Dietrich 2012: 920).

The MLIL index is defined as:

$$MLIL_{s,t} = \sqrt{\sum_{i=1}^{n} x_{i,s} \cdot x_{i,t} \cdot \left(\ln {}^{x_{i,t}} \Big/ {}_{x_{i,s}} \right)^2} \qquad (4)$$

,where $x_{i,t}$ and $x_{i,s}$ are shares of sector i at times t and s, with $x_{i,s} > 0$ and $x_{i,t} > 0$. Compared to the standard Lilien index (Lilien 1982),

$$LIL_{s,t} = \sqrt{\sum_{i=1}^{n} x_{i,t} \cdot \left(\ln {}^{x_{i,t}}\!\!\Big/_{x_{i,s}} \right)^2} \tag{5}$$

$MLIL_{s,t}$ includes the weights of the sector shares, so that the effect of the particular sector in terms of structural change is proportionate to its size as well as its relative growth (Dietrich 2012: 921). The high values of $MLIL_{s,t}$ correspond to high speed of the structural change and substantial reallocations across the sectors, with the index value equal to unity indicating total structural change (conversely index value of zero indicating no change).

Data sources

The empirical analysis is based on the annual data that stretches 1971-2018 period (when variables are represented in growth rates). The panel includes 111 developed, developing and emerging market economies, as outlined in the Appendix.

The gross domestic product (GDP), gross fixed capital formation (GFCF), and exports data were taken from the UNCTAD database (‘Gross Domestic Product: GDP by Type of Expenditure, VA by Kind of Economic Activity, Total and Shares, Annual), with all values measured in the millions of US dollars at constant 2015 prices. Employment data is obtained from the Penn World Table (PWT), Version 10.0, and is represented as the number of persons engaged in economic activity (in millions). The data for the calculation of the structural shares is likewise obtained from the above UNCTAD database. The industry, manufacturing, services, and agriculture shares are calculated as the ratio of the value added created in a respective sector to the GDP. The industry sector includes mining, manufacturing, utilities, and construction; the agriculture includes agricultural commodities production, hunting, forestry, and fishing; while the services include wholesale and retail trade, hospitality and accommodation, transport, storage, communications, as well as other unclassified service activities.

The selection of countries and determination of the time-series dimension of the analysis were dictated by data availability. The PWT and UNCTAD databases respectively cover 1950-2019 and 1970-2018 periods and include 183 and 221 sovereign states and non-sovereign territories; however, the series of sufficient span are available for a more limited number of countries. As a result, for this analysis we excluded many of Eastern European and most former-Soviet Union countries, as well as countries that got independence in the 1990s and the 2000s (e.g. Eritrea, Timor-Leste and South Sudan).

Econometric method

The paper adopted sequential methodology. Firstly, the order of integration and unit root properties of the series was examined. To this end we applied Im-Pesaran-

Shin/IPS, Levin-Lin-Chu/LLC, Breitung, ADF-Fisher χ^2 and PP-Fisher χ^2 tests that are powerful in panels with small and medium time series dimension, but assume cross-section independence.

Additionally, we conducted Mohammad Pesaran (2004, 2015) cross-sectional dependence tests to verify the presence of correlation across the space. The tests are appropriate for settings where $T < N$ and are flexible with regard to T and N combinations. The null of no dependence in Pesaran (2004) test or weak dependence in Pesaran (2015) test is compared with an alternative of strong dependence. In the presence of the latter, the robust cross-sectionally augmented IPS test is applied (Pesaran 2007). The test uses ADF regression with the lag and lag difference of a cross-section term ($\overline{x}_{t-1}$ and $\Delta\overline{x}_{t-j}$), and calculates t-statistic $t_i(p_i)$ of b_i which is the coefficient of the lagged term x_{it-1} in the augmented DF regression. The test statistic is:

$$CIPS(N,T) = \overline{t} = \frac{1}{N}\sum_{i=1}^{N}\tilde{t}_i(N,T) \tag{6}$$

The null hypothesis is that all series are non-stationary ($H_0 : b_i = 0$ for all i), while the alternative is that at least one of the series is stationary.

In the event the null hypothesis of non-stationarity of series is rejected, pooled OLS and model with fixed effects, were estimated:

$$\dot{Y}_{it} = c + \beta\dot{X}_{it} + \varepsilon_{it} \tag{7}$$

$$\dot{Y}_{it} = \left(c + u_i\right) + \beta\dot{X}_{it} + \varepsilon_{it} \tag{8}$$

,where $\dot{Y}_{it}$ is the dependent variable, $\dot{X}_{it}$ is the vector of regressors, c is a common intercept term in pooled OLS, u_i is unobserved and time-invariant individual effect in the model with fixed effects, and $\varepsilon_{it} \sim IID\left(0, \sigma_{\varepsilon}^2\right)$ is an independent and identically distributed error term. The pooled OLS ignores the possibility of individual effects and assumes $u_i = 0$ for every economy, whereas the fixed effects model relaxes the assumption of no systematic differences across the economies and allows for heterogeneous constant terms u_i. The OLS assumptions of no homoscedasticity or autocorrelation, as well as the appropriateness of the fixed effect model or the period effects are verified by respectively by modified Wald, Wooldridge, Hausman and join significance of variables tests. The robust Driskoll-Kraay standard errors are used instead of conventional ones, to address heteroskedasticity, auto- and cross-sectional correlation.

The panel OLS models do not differentiate between short- and long-run effects or capture the dynamic relationships and suffer from the endogeneity problem (correlation between regressors and the error term). We therefore apply panel vector autoregression (PVAR) model designed and estimated in a generalised method of moments (GMM) framework. PVAR of a type developed by Inessa Love and Lea Zicchino (2006) treats all the variables as endogenous (as in conventional VAR framework), allows unobserved country heterogeneity (via introduction of fixed effects), and causal relationships for any pair of variables.[ii]

Michael Abrigo and Inessa Love (2016: 779-80), following Stephen Nickell (1981) note that while panel VAR parameters may be estimated jointly with fixed effects or via ordinary least squares with fixed effects removed through variable transformation, the bias in the estimates may persist due to the presence of lagged dependent variables ('Nickell bias'). Thus the use of GMM estimators is recommended and is likely to deliver consistent results, particularly for the panels where $T < N$.

The PVAR is specified as:

$$Z_{it} = \mu_i + A(L)Z_{it} + \varepsilon_{it} \tag{9}$$

,where $i = 1,\dots,N$, $t = 1,\dots,T$, $Z_{it} = \left[Y, K, L, S, X\right]$ or $Z_{it} = \left[Y, K, L, MLIL, X\right]$ are the vectors of endogenous stationary variables, μ_i is a vector of country fixed effects, $A(L)$ is a matrix polynomial in the lag operator with $A(L) = A_1L^1 + A_2L^2 + \dots + A_pL^p$, and ε_{it} is a residual vector. Given that all (except the modified Lilien structural change index) variables are represented in growth terms but all are $I(0)$, we did not perform the first difference transformation of the variables.

The panel-specific fixed effects are removed using forward orthogonal deviation (Helmert procedure). In contrast to the model with first-differencing (that delivers consistent results, but leads to data loss due to inclusion of the past realisations in the transformation), the Helmert procedure allows keeping past realisations as valid instruments and ensures orthogonality between lagged regressors and transformed variables (Abrigo and Love 2016: 780).

The implementation of PVAR model is conducted consecutively. The optimal lag order of the PVAR is established based on the moment and model selection criteria (MMSC), specifically Bayesian, Akaike and Hannan-Quinn (MBIC, MAIC, MQIC), and taking into account the over-identifying restrictions (Hansen J-statistic). Stability of the model requirement is ascertained, so that all eigenvalue moduli are smaller than one and fall within unit root circle. The PVAR estimates are not interpreted directly (given atheoretical nature of PVAR), thus, inference is made from the impulse-response functions (IRFs) that quantify the effect of the shock in one variable on the present and future values of endogenous variables in the system (i.e. depict variables' adjustment trajectory), while keeping other shocks equal to zero. Due to the likely presence of correlation between system residuals, the shock orthogonalisation via Cholesky decomposition of the residual covariance matrix is performed and the orthogonalised IRFs are constructed. The confidence intervals for the orthogonalised IRFs are constructed based on the Monte Carlo simulations with 500 repetitions. As stated by Abrigo and Love (2016: 793), the coefficients of the reduced-form PVAR cannot be taken to indicate the direction of causality, we conducted panel VAR Granger causality Wald tests with particular focus on the interaction between structural variables and GDP growth rate. Lastly the variance decomposition has been performed to account for the contribution of each shock to the variance of each endogenous variable and the accumulated effects of the shocks over the 10 year period were examined.

The ordering of the variables in VAR (and PVAR) system follows the decreasing order of exogeneity, i.e. the first variable in the causal ordering of variables has contemporaneous effects on all other variables that follow, but any of other variables do not have contemporaneous effects on the first one. The exports is treated as the most exogenous variable (the function of foreign but not domestic GDP), followed by labour force (which is influenced by various non-economic and demographic factors), and gross fixed capital formation. The sectoral value added is component of GDP, while modified Lilien structural index is derived from the sectoral data. The structural variables are thus put ahead of GDP, which is the last variable in the ordering. The ordering in the baseline model is therefore $\left[\dot{X}_t, \dot{L}_t, \dot{K}_t, \dot{S}_t, \dot{Y}_t \right]$. Alternative orderings, while not supported by economic theory (e.g. treating structural variables as the most exogenous) were also tried, yet without substantially altering the findings.

Empirical results

As a first step, the cross-sectional and unit root properties of the series were examined (Table 1). The null hypotheses of no cross-sectional dependence in the Pesaran (2004) test and of weak dependence in the Pesaran (2015) test were both rejected in favour of strong cross-sectional dependence. This contemporaneous correlation is present in diverse cross-sections (developed, developing, and transition economies with various GDP-per-capita levels). It was also observed for the variables most likely to be affected by economic globalisation and integration processes (GDP, exports, and capital formation growth rates, due to rising volumes of trade and investment over recent decades, as well as economic convergence and business cycle synchronisation), as well as variables likely to have country-specific patterns (sectoral shares and speed of structural change). We therefore conducted conventional (‘first-generation’) panel unit root tests that disregarded cross-sectional dependence, as well as the cross-sectionally augmented IPS test (CIPS) that is suited for the series with contemporaneous correlation (Pesaran 2007). The specifications of both types of tests contained constant as deterministic component, given that the series are represented in growth rates. The CIPS test was conducted with a range of lags (one to four).

Table 1. Panel unit root and cross-section dependency tests' results

Var/Test	CD Pesaran	CD Pesaran	LLC	IPS	ADF - Fisher	PP - Fisher
GRGDP	46.4502	252.5120	-27.3617	-30.7422	1395.410	1906.980
GREMP	18.6482	275.7090	-20.2902	-25.6772	1147.510	1623.810
GRGFCF	28.8797	100.3750	-34.9822	-36.4688	1689.190	2399.940
GRX	61.5441	170.3150	-36.4860	-41.1317	1959.860	2979.700
GRINDUS	41.3002	39.7700	-38.1733	-41.3227	1971.990	3169.860
GRAGR	16.3785	31.9560	-35.8066	-45.6492	2221.850	3460.040
GRSERV	37.1423	55.9370	-36.8069	-43.5235	2099.220	3439.620
GRMANUF	19.4311	20.1880	-36.3531	-41.3187	1969.600	3223.290
MLIL	42.5003	421.5500	-21.3661	-24.6388	1096.720	1912.060
GRINVSHAR	18.6563	23.0140	-36.3220	-39.2659	1847.290	2680.830
OPEN	184.3789	503.7030	***5.8781***	***7.1778***	***170.9490***	***216.2960***
GROPEN	62.2747	83.2220	-36.8907	-40.3736	1916.910	3250.990
Var/Test	CIPS (1)	CIPS (2)	CIPS (3)	CIPS (4)		
GRGDP	-3.8740	-3.1650	-2.8380	-2.3530		
GREMP	-3.5850	-2.9430	-2.5770	-2.2530		
GRGFCF	-4.6220	-3.8120	-3.4610	-3.2390		
GRX	-4.6030	-3.5910	-3.2670	-2.7480		
GRINDUS	-4.7100	-3.6440	-3.2530	-2.8170		
GRAGR	-5.1320	-3.8410	-3.3620	-2.9570		
GRSERV	-4.7940	-3.6300	-3.2860	-2.8910		
GRMANUF	-4.9210	-3.8600	-3.1540	-2.7390		
MLIL	-3.8620	-3.0900	-2.7320	-2.4760		
GRINVSHAR	-4.8190	-3.9350	-3.6150	-3.3820		
OPEN	***-1.8360***	***-1.7550***	***-1.7850***	***-1.7230***		
GROPEN	-4.6500	-3.8180	-3.4180	-3.0450		

Note. The values in bold and italics indicate the failure to reject unit root null at the 1% level of significance; the non-highlighted statistics indicate stationarity in levels at the 1% level. The prefix 'GR-' indicates growth rates. The variables included in the analysis are gross domestic product (GDP), labour force (EMP), gross fixed capital formation (GFCF), exports (X), openness (OPEN), sectoral shares of industry, manufacturing, services and agriculture (INDUS, MANUF, SERV, AGR), investment share of GDP (INVSHARE), and modified Lilien index (MLIL).

In the case of the first-generation panel unit root tests, the null hypothesis of unit root behaviour is rejected for all variables (except the openness level), suggesting that all these variables are stationary in their levels. In other words, they have an $I(0)$ order of integration, while the openness level is non-stationary in levels but stationary in the first differences – in effect, it has an $I(1)$ order of integration. The CIPS test results confirm that all variables (except for level of openness) were stationary at levels at each of the four alternative lags, while the level of openness was trend-stationary only in the specification with a single lag and contained unit root at other lags. Two implications are thus drawn: first, given the stationarity of most of the variables (and in particular of the dependent variable, GDP growth rate), a cointegrating relationship is not possible; and second, the openness growth rate is used for the purpose of empirical analysis (given that this variable in levels contains unit root).

The pooled OLS and OLS with fixed effects estimates are based on Equation (1) specification (Tables 2 and 3). In both types of models, the coefficients of the growth rate of employment, gross fixed capital formation, and exports were positive and significant, in line with earlier studies and economic growth theory (Gershon Feder 1982; Robert Barro 1991; Axel Dreher 2006). The coefficients of agriculture and services share growth rates were negative and significant, suggesting that the slack and/or absence of industrialisation in the developing economies – as well as the servicisation tendencies in the developed economies – tends to slow-down economic growth. The coefficients of the industry and manufacturing share growth rates were both positive (albeit significant only in the case of industry share). The modified Lilien index coefficient was positive and significant (at the 10% significance level).

The outcomes of the bivariate polled OLS estimates are identical in terms of the signs and significance of the coefficients. In the multivariate and bivariate OLS specifications with fixed effects, all coefficients are positive and significant, with the exception of manufacturing share growth rate and modified Lilien index (positive but insignificant at conventional levels) and agriculture and services share growth rates (negative and significant). The use of Driskoll–Kraay standard errors is justified given the heteroskedastic and autocorrelated error structure in all cases. (We note, however, that in multivariate models with manufacturing and agriculture share growth rates and modified Lilien index, no autocorrelation is detected.)

Table 2. Pooled OLS model results

Variable/model	1	2	3	4	5
GREMP	0.356	0.359	0.362	0.359	0.364
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRGFCF	0.106	0.110	0.107	0.109	0.109
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRX	0.140	0.140	0.143	0.145	0.144

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRINDUS	0.052				
	(0.000)				
GRSERV		-0.083			
		(0.000)			
GRAGR			-0.033		
			(0.000)		
GRMANUF				0.001	
				(0.870)	
MLIL					0.025
					(0.000)
Constant	1.536	1.581	1.460	1.488	1.280
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Serial correl.	3.066	2.652	2.386	2.401	2.391
	(0.083)	(0.106)	(0.125)	(0.124)	(0.125)
Heterosked.	2458.91	2324.17	2549.46	2801.95	2866.22
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No. observ	5328	5328	5328	5328	5328
R^2	0.377	0.378	0.3725	0.3683	0.37

Note. As per Table 1. The p-values are in the parentheses. Models (1) to (5) include respectively individual sectoral share growth rates or modified Lilien index as a regressor, in addition to the growth rates of employment, gross fixed capital formation and exports.

Table 3. Panel OLS with fixed effects' results

Variable/model	(1)	(2)	(3)	(4)	(5)
GREMP	0.365	0.365	0.366	0.368	0.371
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRGFCF	0.103	0.107	0.105	0.107	0.106
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRX	0.137	0.137	0.140	0.142	0.142

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRINDUS	0.054				
	(0.000)				
GRSERV		-0.085			
		(0.010)			
GRAGR			-0.027		
			(0.014)		
GRMANUF				0.002	
				(0.881)	
MLIL					0.036
					(0.228)
Constant	1.058	1.270	0.952	0.951	0.873
	(0.243)	(0.186)	(0.313)	(0.322)	(0.352)
Serial correlation	3.066	2.652	2.386	2.401	2.391
	(0.083)	(0.106)	(0.125)	(0.124)	(0.125)
Heteroskedasticity	1100000	110000	83399.87	1100000	1300000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cross-section FE	368.160	589.530	784.780	4417.690	1545.020
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Hausman	69.580	21.580	65.660	26.640	18.340
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
No. observations	5328	5328	5328	5328	5328
R^2					
Overall	0.377	0.378	0.373	0.369	0.370
Within	0.367	0.368	0.360	0.357	0.359
Between	0.533	0.540	0.571	0.543	0.535

Note. As per Tables 1 and 2. All models include cross-sectional fixed effects.

In the next step, in order to complement the panel OLS findings, we examined a complete set of the relationships between the variables in a panel VAR system. Given the stationarity of most of the variables, the panel VAR model was applied to the levels of the variables (in the case of the modified Lilien index, the first difference was taken). Table 4 presents the values of the three selection criteria (MAIC, MBIC, and MQIC) at different lags. Based on MAIC, the optimal lag for the PVAR models with agriculture and industry share growth or with modified Lilien index is two, while for the PVAR model with manufacturing and services share growth the suggested lag order is one. In contrast, in all cases, MBIC and MQIC criteria indicate the optimal lag order equal to one. We therefore estimated all PVAR models with lag order one as a baseline specification (as part of the robustness checks, lag order two was also tried). Every PVAR model satisfied the stability condition, with all the eigenvalues positioned inside the unit circle. (Table 5 in the Appendix presents the values of the eigenvalues and their moduli.)

Table 4. PVAR model selection criteria

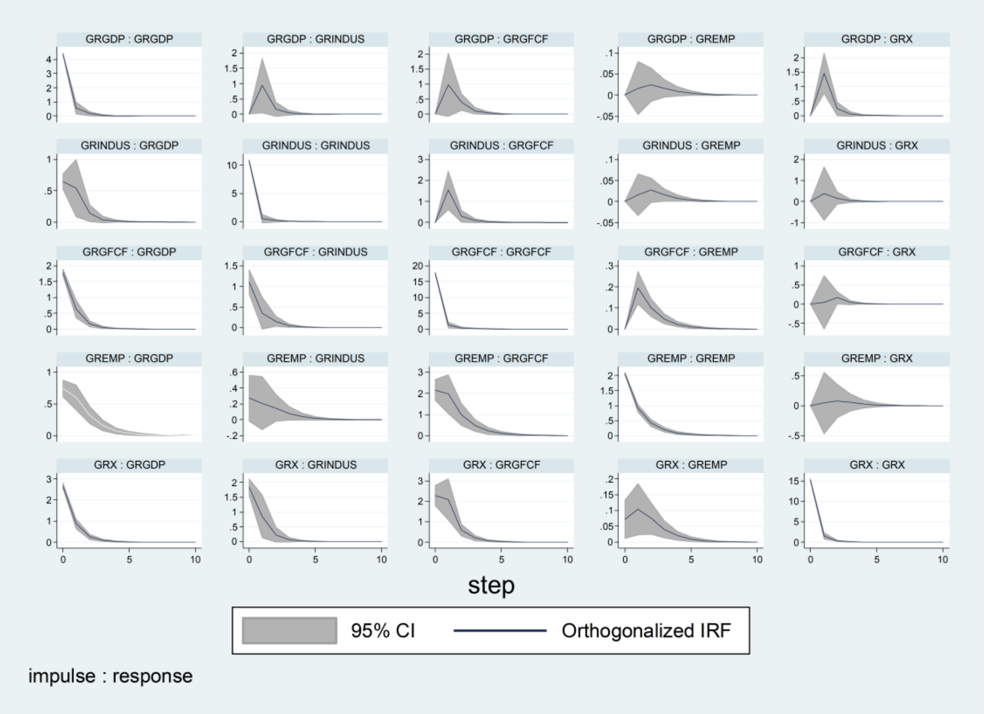
PVAR with industry share			
Lag	MBIC	MAIC	MQIC
1	-678.1640	-33.4439	-260.2110
2	-517.1685	-33.6285	-203.7038
3	-357.4915	-35.1315	-148.5150
4	-177.8332	-16.6531	-73.3440
PVAR with manufacturing share			
Lag	MBIC	MAIC	MQIC
1	-673.0662	-28.3462	-255.1132
2	-502.6615	-19.1215	-189.1968
3	-345.3181	-22.9582	-136.3417
4	-170.1450	-8.9650	-65.6568
PVAR with agriculture share			
Lag	MBIC	MAIC	MQIC
1	-652.9952	-8.2752	-235.0422
2	-515.9934	-32.4534	-202.5287
3	-353.9030	-31.5430	-144.9265
4	-181.0206	-19.8406	-76.5324
PVAR with services share			
Lag	MBIC	MAIC	MQIC
1	-665.0169	-20.2969	-247.0639
2	-503.0182	-19.4782	-189.5535
3	-340.7251	-18.3651	-131.7486
4	-171.7732	-10.5932	-67.2850
PVAR with modified Lilien index			
Lag	MBIC	MAIC	MQIC
1	-657.9048	-13.1849	-239.9518
2	-506.6670	-23.1270	-193.2023
3	-338.9838	-16.6238	-130.2023
4	-163.6378	-2.4578	-59.1496

Given that the estimates of the PVAR model are not amenable to direct interpretation (due to the atheoretic nature of the PVAR system), we relied on the analysis of the orthogonalised impulse–response functions (Figure 1). In each of the five PVAR models that were estimated, the GDP growth rate’s own effects were positive, immediately significant, but short-lived, reducing to zero in fewer than five periods (on average, in two or three periods). The effects of gross fixed capital formation, employment, and exports growth rates on GDP growth rate were likewise positive and immediately significant (in line with growth theory predictions), attenuating in up to five periods (the effects of the employment growth rate were generally more prolonged). The effects' dissimilarities concerned the structural variables. The effect of industry share on GDP was positive and significant, but only in the first two periods. GDP growth rate responded negatively to shocks in the services and agriculture shares (significant effects in, respectively, the first and in the first two periods). The effect on GDP growth rate of manufacturing share was insignificant, with the sign of the effect alternating from positive in the first period to negative in the second. The speed of structural change (measured by the modified Lilien index) positively influenced GDP growth rate, but the effect was significant only in the second and third periods.

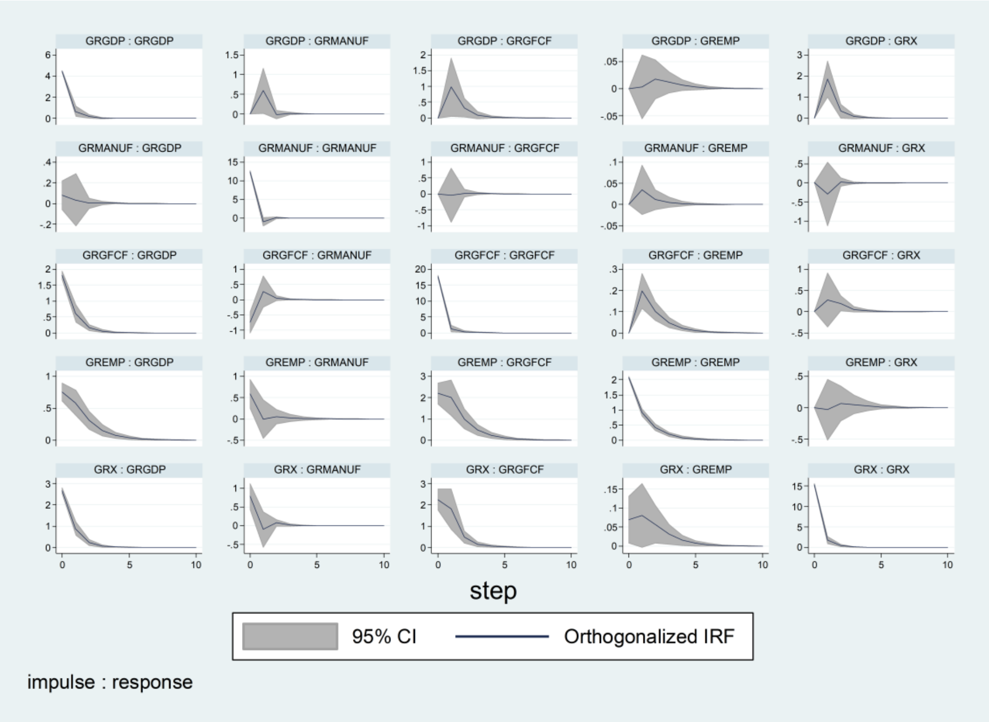
We also note that the influence of the variables on employment growth rate was positive in most PVAR models (with the exception of the services share growth rate). The growth rate of gross fixed capital formation responded positively to shocks in other variables (with the exception of the services and agricultural share growth rates). In the equation for export growth rates, the responses were generally positive (with the exception of the response of exports to industry, manufacturing, and agricultural share growth rates and to the employment growth rate in the PVAR models with industry, agriculture, and modified Lilien index). The effects of the variables on the structural variables were inconsistent: mostly positive in relation to industry and manufacturing shares, mostly negative in terms of agricultural share and the modified Lilien index, and mixed in relation to the services share.

Figure 1. Impulse-response functions (baseline model)

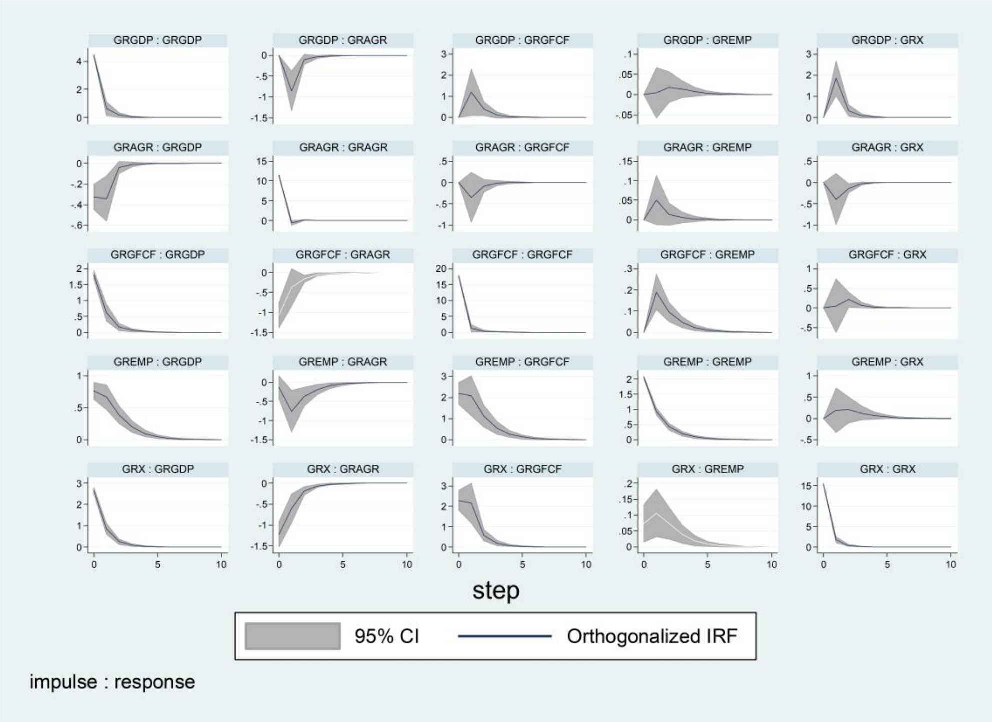
Model with industry share growth rate



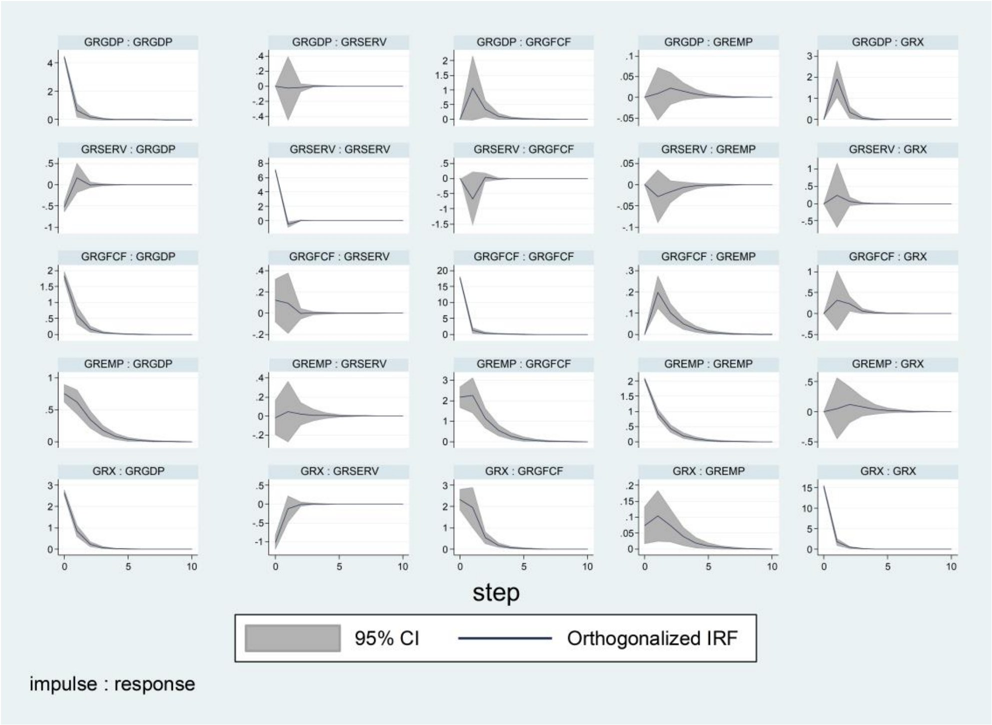
Model with manufacturing share growth rate



Model with agriculture share growth rate



Model with services share growth rate



Model with modified Lilien index

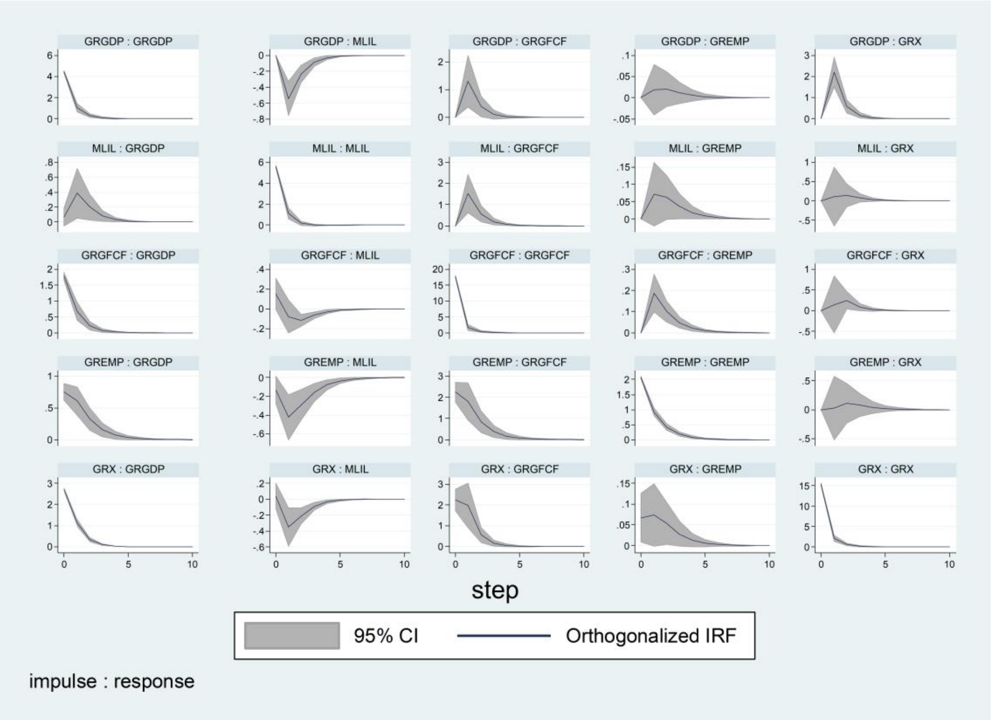


Table 6 presents the summary of forecast error variance decompositions for each PVAR model (to conserve space, only the selected forecast horizons are included). The table presents the findings in a row format, where the variation indicated in the row headings is explained in terms of the variation indicated in the column headings (e.g., the second line of the table shows that variation in employment, fixed capital, industry share, and GDP explain only 0.01%, 0.01%, 0.07%, and 0.92%, respectively, of variation in export growth rate, while own variation of exports explains 98.99% of the dependent variable variation).

In each model, the GDP growth rate own variation was the main driver of changes in the dependent variable (with contributions ranging from 59.43% to 61.53% after 10 years), followed by variation in the exports and gross fixed capital formation growth rates (between 23.73% and 25.28%, and 10.66% and 11.39%, respectively). The contribution of the structural variables was on par with the employment growth rate (explaining between 3.09% and 3.73% of the GDP growth rate variation): the contributions of the industry, agriculture, services, and manufacturing shares and the modified Lilien index stood respectively at 2.22%, 0.67%, 0.91%, 0.002%, and 0.59%. The structural variables therefore had significant but not sizeable effects on economic growth.

Table 6. PVAR forecast error variance decomposition results

Eqt/Var.	GRX	GREMP	GRGFCF	GRINDUS	GRGDP
GRX	98.99	0.01	0.01	0.07	0.92
GREMP	0.44	98.56	0.95	0.02	0.02
GFGFCF	2.96	2.91	93.06	0.73	0.34
GRINDUS	3.34	0.12	1.11	94.70	0.73
GRGDP	24.06	3.20	11.09	2.22	59.43
Eqt/Var.	GRX	GREMP	GRGFCF	GRMANUF	GRGDP
GRX	98.45	0.00	0.05	0.03	1.46
GREMP	0.30	98.70	0.97	0.02	0.01
GRGFCF	2.54	3.01	94.14	0.00	0.32
GRMANUF	0.40	0.23	0.41	98.74	0.22
GDGDP	24.10	3.15	11.20	0.02	61.53
Eqt/Var.	GRX	GREMP	GRGFCF	GRAGR	GRGDP
GRX	98.40	0.04	0.02	0.07	1.46
GREMP	0.45	98.60	0.89	0.05	0.01
GRGFCF	3.03	3.20	93.27	0.04	0.47
GRAGR	1.40	0.57	0.96	96.51	0.55
GRGDP	23.73	3.73	11.21	0.68	60.65
Eqt/Var.	GRX	GREMP	GRGFCF	GRSERV	GRGDP
GRX	98.35	0.01	0.06	0.03	1.55
GREMP	0.44	98.56	0.97	0.02	0.02
GRGFCF	2.83	3.44	93.21	0.14	0.38
GRSERV	2.08	0.01	0.05	97.87	0.00
GRGDP	23.81	3.42	11.39	0.91	60.47
Eqt/Var.	GRX	GREMP	GRGFCF	MLIL	GRGDP
GRX	97.83	0.01	0.04	0.02	2.11
GREMP	0.25	98.65	0.88	0.20	0.02
GRGFCF	2.71	2.71	93.23	0.79	0.56
MLIL	0.53	0.93	0.14	97.34	1.06
GRGDP	25.28	3.09	10.66	0.59	60.38

Note. Percent of variation in the row variable is explained 10 periods ahead.

Table 7 contains the findings of the panel VAR Granger causality Wald tests. The first test examined whether the coefficients of the lags of the structural variable in the GDP growth equation or the lags of the GDP growth rate in the structural variable equation were jointly zero (i.e., the null hypothesis stated that there was no Granger causality). The second test (with the outcome labelled ‘ALL’) considered whether the coefficients of the lags of all endogenous variables – apart from the dependent one – were jointly zero, thus the former did not Granger-cause the latter (Abrigo and Love 2016: 793).

Table 7. Panel Granger causality test results

Eqt/Var.	GRX	GREMP	GRGFCF	GRINDUS	GRGDP	All
GRX		0.610	0.161	0.800	0.004	0.004
GREMP	0.290		0.000	0.559	0.600	0.000
GFGFCF	0.046	0.000		0.008	0.060	0.000
GRINDUS	0.286	0.806	0.711		0.027	0.010
GDGDP	0.003	0.000	0.013	0.061		0.000
Eqt/Var.	GRX	GREMP	GRGFCF	GRMANUF	GRGDP	All
GRX		0.324	0.206	0.439	0.000	0.000
GREMP	0.559		0.000	0.236	0.912	0.000
GFGFCF	0.054	0.000		0.877	0.073	0.000
GRMANUF	0.109	0.821	0.909		0.053	0.257
GDGDP	0.002	0.000	0.017	0.856		0.000
Eqt/Var.	GRX	GREMP	GRGFCF	GRAGR	GRGDP	All
GRX		0.874	0.059	0.434	0.000	0.000
GREMP	0.151		0.000	0.127	0.886	0.000
GFGFCF	0.019	0.000		0.412	0.026	0.000
GRAGR	0.485	0.021	0.766		0.001	0.000
GDGDP	0.005	0.000	0.021	0.014		0.000
Eqt/Var.	GRX	GREMP	GRGFCF	GRSERV	GRGDP	All
GRX		0.419	0.221	0.368	0.000	0.000
GREMP	0.304		0.000	0.389	0.771	0.000
GFGFCF	0.046	0.000		0.250	0.053	0.000
GRSERV	0.273	0.837	0.466		0.891	0.722
GDGDP	0.002	0.000	0.017	0.205		0.000
Eqt/Var.	GRX	GREMP	GRGFCF	MLIL	GRGDP	All
GRX		0.395	0.065	0.864	0.000	0.000
GREMP	0.783		0.000	0.141	0.546	0.000
GFGFCF	0.071	0.001		0.002	0.010	0.000
MLIL	0.799	0.014	0.238		0.000	0.000
GDGDP	0.001	0.000	0.059	0.051		0.000

Note. The table contains p-values of the PVAR Granger-causality Wald test.

In the PVAR model with the industry share growth rate as a structural variable, both tests rejected the null hypothesis of no Granger causality (at the 5% and 10% significance levels), while indicating bi-directional causality (the growth of industry share stimulates economic growth, while the latter leads to the growth of industry share). In the PVAR models with agriculture share growth rate or modified Lilien index, the null hypothesis was likewise rejected (in both cases, at either the 1% or the 5% significance level) and similar causality patterns were established. In the PVAR models with the manufacturing or services share growth rate, the null hypothesis is not rejected, hence there is no causal relationships between structural variables and economic growth (in the case of manufacturing, however, there was causality between GDP growth rate and manufacturing share).

In addition to the above baseline specification, we performed a number of robustness checks. First, the standard panel OLS techniques with or without fixed effects assume the absence of cross sectional correlation (dependence) between the individual panel members. To deal with the dependence identified by the Pesaran CD tests, we applied the common correlated effects model and its dynamic version. In both models, the regressions of the GDP growth rate on the growth rate of employment, fixed capital, exports, and either sectoral shares or modified Lilien index were augmented by the cross sectional averages of the dependent and independent variables (in the dynamic version, the lags of the cross-sectional averages were also added). The models used a mean-group estimator, and in the case of the dynamic model, included four lags of the cross-sectional averages (Ditzen [2018] recommends that the lag length is given as $l = \sqrt[3]{N} = \sqrt[3]{48} = 3.6342 \approx 4$). As demonstrated in Table 8, all regressions were correctly specified, with no rejections of the null hypothesis of cross-sectional dependence in every instance (i.e., the p-value of CD test statistics exceeding the 5% significance level). The signs and significance of the structural variables' coefficients do not differ from the baseline specifications: the positive and significant effects of industry share and modified Lilien index, the negative influence of services and agriculture share, and the insignificant effect on manufacturing share.

Second, we considered bivariate panel VAR (including only the GDP growth rate and relevant structural variable). The relevant results are presented in Figure 3 and Table 9. The shapes of the impulse–response functions and the outcomes of the panel Granger causality tests are likewise similar to the baseline specification. There are positive effects of industry share and modified Lilien index on growth, alongside a negative influence of agriculture and services share, and the absence of significant effects of manufacturing share. Bidirectional Granger causality with GDP growth was demonstrated for the industry and agriculture shares and modified Lilien index. There is no causality in any direction for the 'manufacturing share–growth rate' and 'services share–growth rate' pairs.

Third, estimates were performed for the three sub-panels of high-, middle-, and low-income economies (classified on the basis proposed by the World Bank). The impulse–response functions and Granger causality tests results are reported in Figure 4 and Table 10. The findings are similar to the baseline specification results in many respects. A positive effect of industry share on growth was identified in the high- and middle-income economies (in the low-income group, the effect was also positive, but insignificant). Negative effects of agriculture share were witnessed in all three groups, similar to the baseline model. The positive influence of the speed of structural change (Modified Lilien index) was observed in high- and middle-income economies (in the latter case, the effect was marginally significant). In the low-income economies, the effect was likewise positive, but insignificant. Manufacturing share had a positive influence on growth in the high-income economies (likely due to the high-value added and technologically advanced manufacturing). The manufacturing effects in the other two groups were insignificant. The major difference from the baseline model is the positive effect of the services sector in the least-developed low-income economies. The role of services in the economic transformation of developing economies has been documented on a number of occasions (Nayyar et al. 2021). This is due to the sheer size of the services employment in the Third World, the modified function of the modern services sector (services as enabler and complement to manufacturing), and the technological change in services (that allows developing economies to capitalise on a low-cost but qualified labour force in areas such as tourism and IT, as well as professional-, technical-, and business-service exports).

Finally, we performed additional checks. We replaced gross fixed capital formation and export growth rate with investment share and openness variables, while keeping all other variables intact. The outlier values in the structural variables were eliminated (the highest growth rates of sectoral shares and modified Lilien index)[iii] and the baseline specification was re-estimated. The variables in the baseline specification were re-ordered, with the structural variable placed as a first or second variable in the ordering). In addition, the PVAR models with lag order two were estimated, based on the minimised value of the MAIC criterion and the observation by Serena Ng and Pierre Perron (2001) that MAIC gives a correct indication of the lag order structure. The results of these modified models were not fundamentally different from those in the baseline model and hence – to conserve space – are not reported here.

Table 8. (Dynamic) common correlated effects results

CCE Model	1	2	3	4	5
GREMP	0.252	0.245	0.243	0.266	0.258

	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRGFCF	0.158	0.158	0.159	0.158	0.151
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRX	0.095	0.103	0.094	0.092	0.088
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRINDUS	0.026				
	(0.066)				
GRSERV		-0.096			
		(0.004)			
GRAGR			-0.006		
			(0.601)		
GRMANUF				-0.024	
				(0.328)	
MLIL					0.206
					(0.002)
Constant	-0.009	0.048	-0.047	0.258	0.164
	(0.986)	(0.910)	(0.923)	(0.570)	(0.803)
CD	1.840	1.800	1.750	1.430	0.580
	(0.065)	(0.073)	(0.081)	(0.152)	(0.564)
R^2	0.63	0.63	0.63	0.66	0.62

Table 8. (cont).

Variable/model	1	2	3	4	5
GREMP	0.339	0.214	0.346	0.287	0.432

	(0.000)	(0.015)	(0.002)	(0.006)	(0.005)
GRGFCF	0.165	0.168	0.172	0.158	0.163
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRX	0.106	0.109	0.103	0.092	0.108
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
GRINDUS	0.051				
	(0.093)				
GRSERV		-0.097			
		(0.040)			
GRAGR			-0.021		
			(0.271)		
GRMANUF				-0.006	
				(0.880)	
MLIL					0.110
					(0.095)
Constant	-0.623	1.534		0.884	1.162
	(0.748)	(0.153)		(0.449)	(0.758)
CD	1.670	0.380	-0.650	0.870	-0.360
	(0.095)	(0.705)	(0.517)	(0.384)	(0.721)
R^2	0.70	0.72	0.70	0.67	0.62

Note. As per Table 1.

Conclusion

This paper has examined the relationship between structural change variables (sectoral shares and the speed of structural change, represented by the modified Lilien index) and GDP growth rate. The estimates were performed for a large panel, consisting of 111 developed, developing, and transition economies during the period of 1971–2018. The baseline specification included labour and capital inputs (the latter represented by a gross fixed capital formation), exports, and the relevant structural variable. For the purpose of robustness checks, alternative specifications were also tried (models with investment share as a capital variable or without outlier economies or the bivariate model). The presence of stationarity and cross-sectional dependence in the levels of the variables dictated the use of panel OLS and panel VAR models.

All the estimated models were correctly specified, as attested by diagnostic tests. The contribution of labour and capital variables as well as exports to GDP growth was positive, in line with the existing empirical literature and theoretical predictions. The expansion of the agricultural and services shares of GDP had a negative effect on economic growth in every model or specification, while the contributions of the industry share and modified Lilien index were positive (the coefficient of the latter variable was significant in most but not all models). The effect of the manufacturing share of GDP was positive in all instances, albeit insignificant. The causality analysis confirmed the finding of a bilateral causality between agriculture, industry share, and modified Lilien index on one hand and economic growth on the other. In contrast, there was no causality in either direction between economic growth and the manufacturing and services shares.

The findings are generally in line with those of earlier studies. As far as bilateral causality is concerned, the results appear to confirm earlier insights on the coevolutionary nature of the relationship between structural change (and structural variables overall) and economic growth (Dietrich 2012: 939; Saviotti and Pyka 2008). Structural transformation may slow down growth (e.g., the negative effects of the rise of the services sector; Baumol 1967) or, conversely, accelerate it (e.g., industrialisation and the development of the manufacturing sector; Kaldor 1967). On the other hand, faster growth and higher income levels may induce changes in demand and – later – in the production structure (Pasinetti 1981; Dietrich 2012: 935).

While a higher speed of structural change was conducive for growth, the effects of sectoral shares varied. The negative effects of expanding the services sector share (servicisation) were evident in every specification, thus giving support to Baumol's cost disease thesis. This finding was also in line with those of earlier studies (e.g., Ansari's 1992 study in the Canadian context). The negative effects of agricultural share on growth and income were as expected, in line with the theses of the development economists of the 1950s and 60s (Bruce Johnston and John Mellor 1961).

The influence of the industry and manufacturing shares was positive (albeit in the case of manufacturing, statistically insignificant). This pattern may be attributed to the following. Compared to the 1960s, when Kaldor's thesis was formulated, manufacturing's contribution to GDP had declined substantially and the manufacturing landscape had reduced. While formidable manufacturing growth was being experienced in many developing countries (e.g., China and South-East Asia), manufacturing was in decline almost universally across the developed world, as well as in the transitioning and many of the developing economies. In the panel used in this study, negative and positive growth in manufacturing share was experienced in 60 and 51 economies, respectively (compared to 52 and 59 economies for a broader industry share), with the average growth in manufacturing share across all economies being 0.10% per annum (compared to 0.18% per annum growth in the industry share). The fact that the effect of manufacturing share was nonetheless positive, despite its declining trend (Figure 2 in the Appendix), gives support to Kaldor's thesis.[iv] In addition, the positive but insignificant effect of manufacturing could be attributed to the aggregation of the range of quite diverse manufacturing industries. Arguably, the exclusion of stagnant manufacturing (e.g., heavy industry and textiles) in the developed economies could have altered the findings. A similar logic can be applied to the effects of the services sector, where knowledge-intensive activities such as IT – and professional, scientific, and technical services – are likely to enhance productivity and growth, where public administration and personal services are not (Dale Jorgenson and Marcel Timmer 2011).

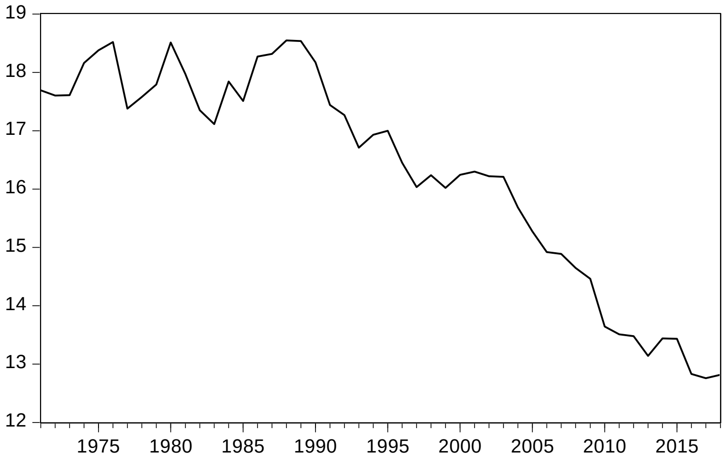
The findings of this study confirm the importance of policies and reform that foster productivity-enhancing structural change and allow countries to capture the positive effects of structural changes: for example, the modernisation of agriculture (to release labour and capital from agriculture for use in other sectors); measures to slow down premature deindustrialisation (especially in middle-income economies) or to cushion against the negative effects of trade liberalisation on domestic industries; macroeconomic policies to curb Dutch disease and currency appreciation (which make industrial exports uncompetitive); and so on. We note, however, that several factors behind the decline of manufacturing share are beyond policy control (i.e., a general slowdown in capital accumulation that affects manufacturing more than other sectors and the decline in consumer spending on manufactured goods).

Appendix

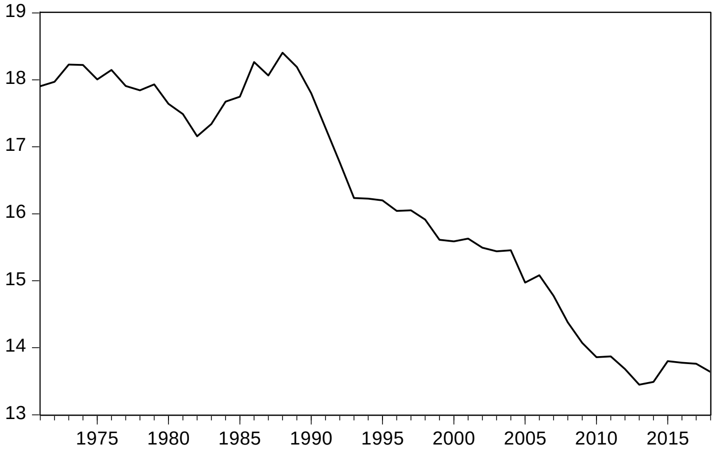
The panel includes a total of 111 economies as follows: Albania, Algeria, Angola, Argentina, Australia, Austria, Bahrain, Bangladesh, Barbados, Belgium, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Cambodia, Cameroon, Canada, Chad, Chile, PR China, China (Hong Kong SAR), Republic of China (Taiwan), Colombia, Congo, DR Congo, Costa Rica, Cote D'Ivoire, Cyprus, Denmark, Dominican Republic, Ecuador, Egypt, Ethiopia, Finland, France, Gabon, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hungary, Iceland, India, Indonesia, Iran, Iraq, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Kuwait, Lebanon, Luxembourg, Madagascar, Malawi, Malaysia, Mali, Malta, Mauritius, Mexico, Morocco, Mozambique, Myanmar, Namibia, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Rwanda, Saudi Arabia, Senegal, Singapore, South Africa, Spain, Sri Lanka, Sudan, Sweden, Switzerland, Syria, Tanzania, Thailand, Trinidad and Tobago, Tunisia, Turkey, Uganda, UAE, UK, USA, Uruguay, Venezuela, Vietnam, Zambia and Zimbabwe.

Figure 2. Fluctuation of the manufacturing share of GDP

Median of MANUF



Mean of MANUF



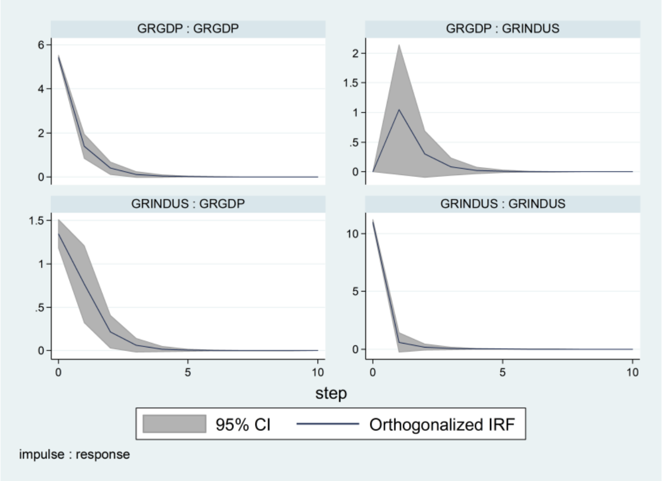
Note. The figures indicate the mean and median of the cross-sections in the panel.

Table 5. PVAR stability diagnostics (eigenvalue stability conditions)

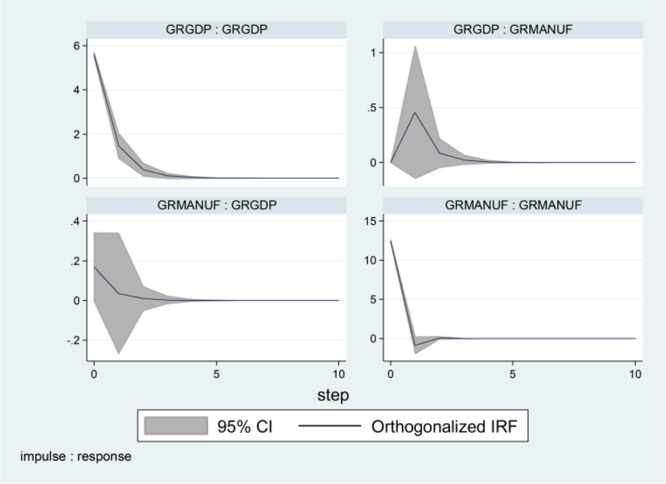
PVAR with industry share			PVAR with services share		
Real	Imaginary	Modulus	Real	Imaginary	Modulus
0.4612	0.0000	0.4612	0.4721	0.0000	0.4721
0.2266	0.0000	0.2266	0.2163	0.0000	0.2163
-0.0175	-0.0385	0.0423	-0.0763	0.0000	0.0763
-0.0175	0.0385	0.0423	-0.0045	-0.0429	0.0432
0.0260	0.0000	0.0260	-0.0045	0.0429	0.0432
PVAR with manufacturing share			PVAR with modified Lilien index		
Real	Imaginary	Modulus	Real	Imaginary	Modulus
0.4607	0.0000	0.4607	0.4452	0.0000	0.4452
0.2202	0.0000	0.2202	0.2547	0.0554	0.2606
-0.0902	0.0000	0.0902	0.2547	-0.0554	0.2606
0.0070	-0.0304	0.0311	0.0145	0.0202	0.0249
0.0070	0.0304	0.0311	0.0145	-0.0201	0.0249
PVAR with agriculture share					
Real	Imaginary	Modulus			
0.4705	0.0000	0.4705			
0.2200	0.0000	0.2200			
-0.0810	0.0000	0.0810			
0.0047	-0.0419	0.0422			
0.0047	0.0419	0.0422			

Figure 3. Impulse-response functions (bivariate model)

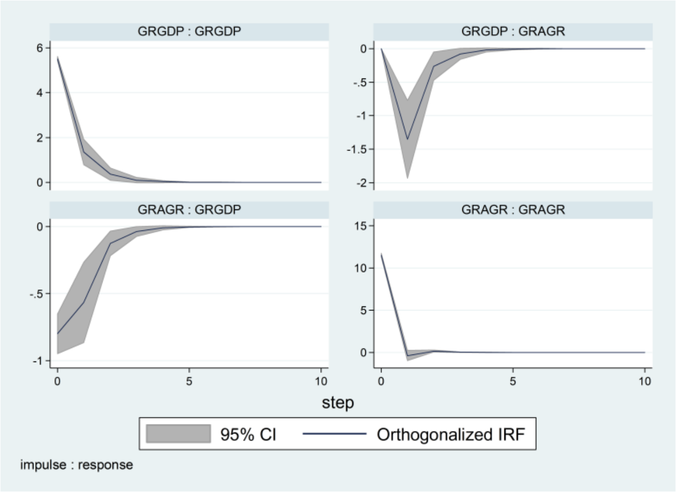
Model with industry share growth rate



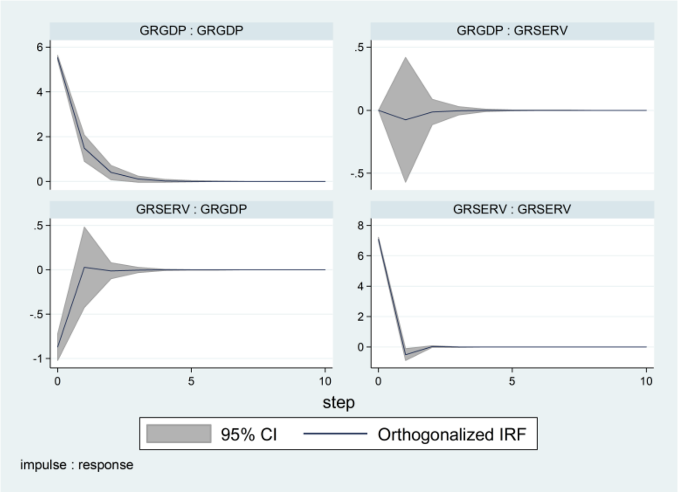
Model with manufacturing share growth rate



Model with agriculture share growth rate



Model with services share growth rate



Model with modified Lilien index

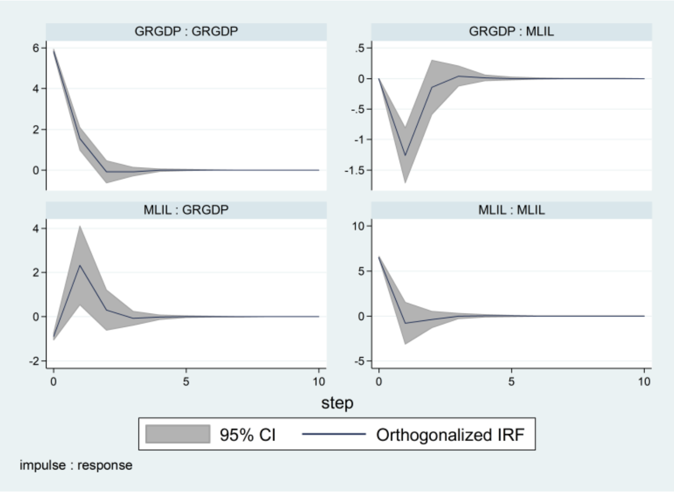


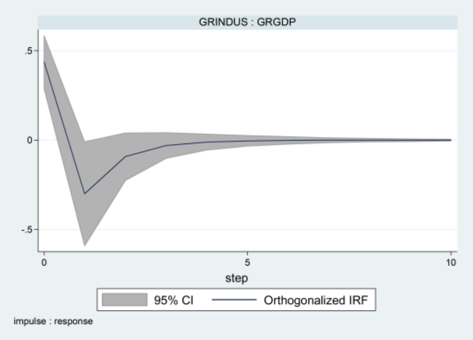
Table 9. Panel Granger causality test results (bivariate models)

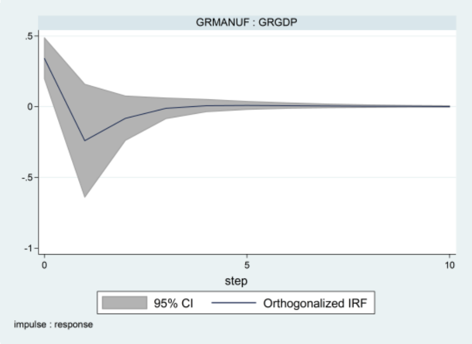
Eqt/Var.	GRINDUS	GRGDP	All
GRINDUS		0.068	0.068
GDGDP	0.079		0.079
Eqt/Var.	GRMANUF	GRGDP	All
GRMANUF		0.196	0.196
GDGDP	0.953		0.953
Eqt/Var.	GRAGR	GRGDP	All
GRAGR		0.000	0.000
GDGDP	0.011		0.011
Eqt/Var.	GRSERV	GRGDP	All
GRSERV		0.759	0.759
GDGDP	0.259		0.259
Eqt/Var.	MLIL	GRGDP	All
MLIL		0.000	0.000
GDGDP	0.003		0.003

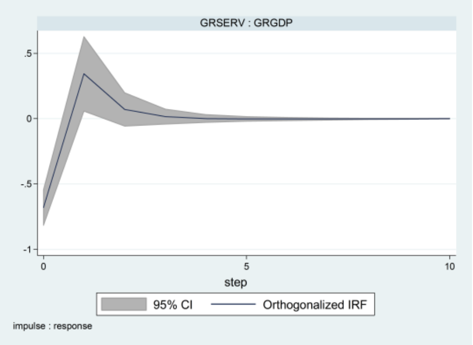
Note. As per Table 7.

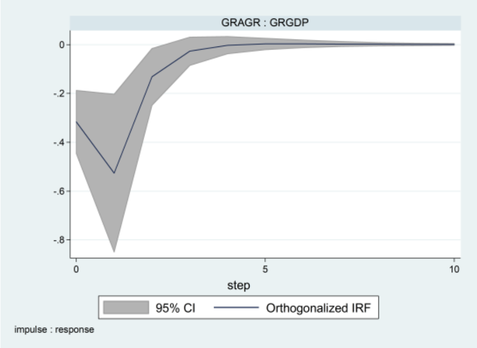
Figure 4. Structural variables - economic growth impulse-response functions (sub-panels)

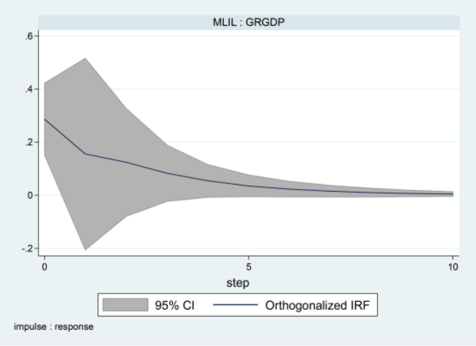
High income economies



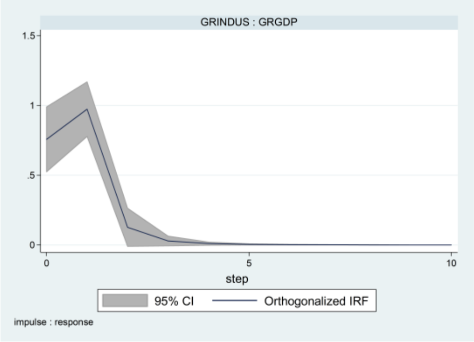


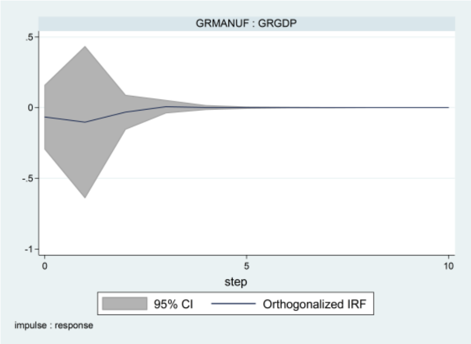


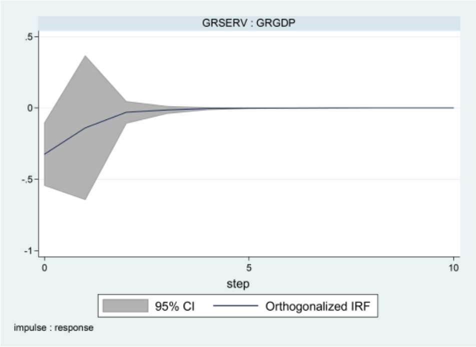


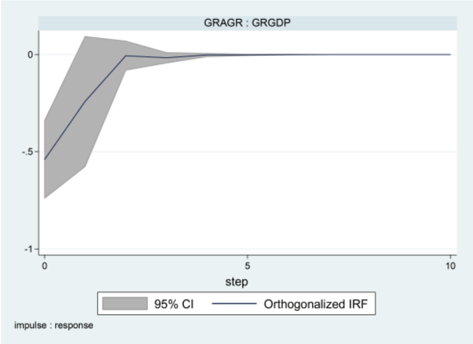


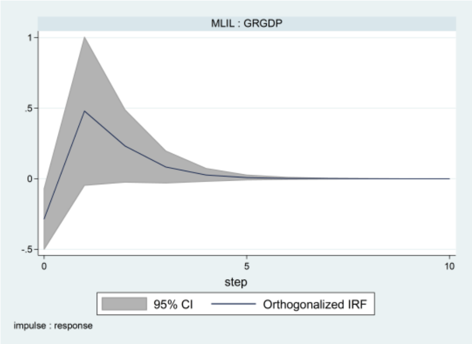
Middle income economies



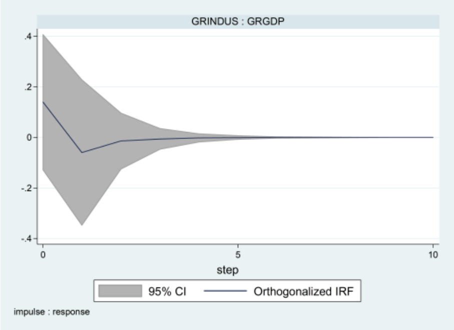


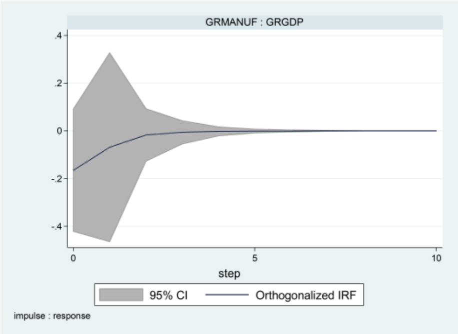


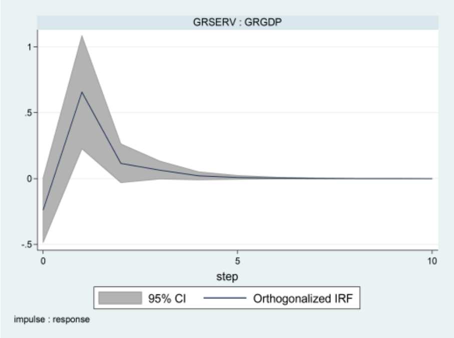


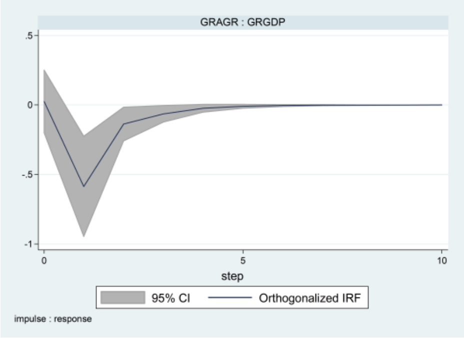


Low income economies









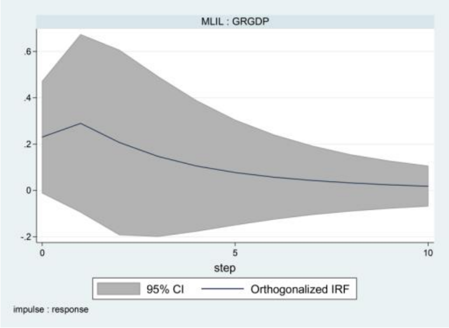


Table 10. Panel Granger causality test results (sub-panels)

Group	High income economies			Low income economies		
Eqt/Var.	GRINDUS	GRGDP	All	GRINDUS	GRGDP	All
GRINDUS		0.059	0.001		0.033	0.043
GDGDP	0.009		0.000	0.539		0.084
Eqt/Var.	GRMANUF	GRGDP	All	GRMANUF	GRGDP	All
GRMANUF		0.625	0.453		0.342	0.263
GDGDP	0.118		0.000	0.919		0.222
Eqt/Var.	GRAGR	GRGDP	All	GRAGR	GRGDP	All
GRAGR		0.014	0.003		0.001	0.003
GDGDP	0.009		0.000	0.001		0.002
Eqt/Var.	GRSERV	GRGDP	All	GRSERV	GRGDP	All
GRSERV		0.182	0.161		0.003	0.016
GDGDP	0.001		0.000	0.001		0.002
Eqt/Var.	MLIL	GRGDP	All	MLIL	GRGDP	All
MLIL		0.000	0.000		0.341	0.113
GDGDP	0.749		0.052	0.290		0.306
Group	Middle income economies					
Eqt/Var.	GRINDUS	GRGDP	All			
GRINDUS		0.181	0.026			
GDGDP	0.000		0.000			
Eqt/Var.	GRMANUF	GRGDP	All			
GRMANUF		0.909	0.540			
GDGDP	0.717		0.000			
Eqt/Var.	GRAGR	GRGDP	All			
GRAGR		0.003	0.001			
GDGDP	0.226		0.000			
Eqt/Var.	GRSERV	GRGDP	All			
GRSERV		0.176	0.277			
GDGDP	0.610		0.000			
Eqt/Var.	MLIL	GRGDP	All			
MLIL		0.005	0.000			
GDGDP	0.076		0.000			

Note. As per Table 7.

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[i] A related stream of empirical research examines the productivity effects of structural change. The earlier paper did not specify the sectoral equations and tended to focus on the aggregate level of transfers between the sectors (e.g. agriculture and industry) as a contributing factor to growth (Sherman Robinson 1971; Feder 1986), or attempted to decompose the aggregate productivity to account for sectoral contributions (Tetsushi Sonobe and Keijiro Otsuka 1997). More recent studies examined the problem by using augmented Solow model (where growth due to increase in capital, labour, land, and due to technical change was complemented by growth due to reallocation of resources across sectors). The separate sectoral production functions were estimated, and the assumption of constant differentials between sectoral productivities was waived. For instance, Fan et al (2003) adopting this approach in the study of China's economic growth demonstrated higher significance of reallocations and lower productivity in agriculture compared to other sectors, hence the need in rural development and further reallocations (Fan et al. 2003).

[ii] The methodology was used extensively in empirical research. See, for instance, the study by Silvo Dajcman (2017).

[iii] The removed outlier economies were as follows: Kuwait, Zimbabwe (agricultural share of GDP); Bangladesh, Iraq, (industry share); Oman, Syria, UAE and Zimbabwe (manufacturing share); Albania, Iraq, Kuwait, Malawi, Mali, Oman, Rwanda (services share); Brazil, China, Saudi Arabia and USA (modified Lilien index). A glance at recent economic history suggests that the majority of the economies in the list experienced substantial structural transformations during the study period, e.g. rapid economic development (China, Oman, UAE) or demise (Zimbabwe), war shocks (Iraq, Kuwait, Syria).

[iv] The trends in manufacturing (share) warrants separate investigation. As argued by Tregenna (2009: 437), the decline in manufacturing share may in fact be a statistical artefact that may indicate simultaneous decline in relative prices of manufactured goods and constant or increasing quantity of manufacturing output, or the outsourcing of manufacturing activities.