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SPIRALLING CONSTRUCTION COSTS DURING CONSTRUCTION BOOM: WHAT DRIVES THE CONSTRUCTION MATERIAL MARKETS?

The article explores the dynamics of building material prices by examining global and local markets. The research identifies the factors influencing price fluctuations and investigates whether these factors stem from demand-side or supply-side influences. Based on the literature and collected data, the study highlights that building materials, such as cement and steel, are critical to the construction sector, with major producers including China, India, Turkey, Germany, and the US. While price developments are influenced by global supply-demand dynamics, raw material prices, trade policies, supply chain disruptions, and China's economic activity, the post-Covid spike in construction prices was driven by macroeconomic imbalances and supply chain disruptions. Our empirical assessments imply that this price spike was transferred to Armenia, as global

prices are a key determinant for Armenia's import-dependent construction sector. Another important determinant was Armenia's GDP gap, with a transition mechanism working through the demand for construction, and hence – demand for construction materials and inflationary pressures stemming from them. The research results imply, that business and policy planning in the construction sector can benefit from forecasting construction prices given a realistic input of assumptions on external and domestic variables.

Keywords: *construction, building materials market, steel, cement, construction price.*

JEL: L74, Q31

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INTRODUCTION. The residential construction boom in Armenia, fueled by government subsidy programs (primarily income tax refunds for mortgage interest payments), created various imbalances in the economy, including prices, financial intermediation, the labor market, and imports.

The construction boom also coincided with a spike in construction prices, which are generally affected by various domestic and external factors some of which may be inflationary and some deflationary. One of the key inflationary factors was external prices, which might be affected by macroeconomic trends and market structure.

The global market for building materials has remained similar over the years. The major players are China, Turkey, Iran, Germany, and the USA. Building material price surges occurred during the financial crisis in 2008-2009, and the second sharp increase occurred in 2021-2022 during the pandemic and post-pandemic periods. Understanding the determinants of construction prices in Armenia is important.

The article attempts to analyze the global market for construction materials and quantitatively assess the effects of domestic and external factors. For this reason, it analyzes the structure and trends of the global market and assesses, based on econometric analysis, the factors determining the construction price dynamics.

LITERATURE REVIEW. As an important driver of the economy, the construction sector faces challenges regarding construction project costs and feasibility. The main cause of these problems is the availability and prices of building materials. Like the other sectors, domestic and external factors also affect the construction sector. These interactions are shaping the development of building material prices. It can be noted that the prices for intermediate inputs, such as cement, broadband internet, steel reinforcement bars, and urea fertilizer, are higher in developing countries (Leone F., Macchiavello R. and Reed T., 2022).

The literature suggests factors that are shaping building material prices and their trends. The main determinants of the price dynamics are energy costs, inflation, raw material and logistic costs, import duties, exchange rate, oil price, market conditions, and the country's macroeconomic policy (Windapo, A. O., & Cattell, K. 2010).

Following other authors (Uvarova S.S., Belyaeva S. V., Bolgov V. A., 2023) who differentiated the factors affecting the building material prices, there are two main groups of factors – geopolitical (import substitution, restriction of imports, reduction of foreign investments, import of technological equipment) and economic. In turn, the group of economic factors was considered a set of market and non-market factors. Market factors are:

- the dynamics of demand and supply,
- changes in the supply dynamics of internal logistics flows,
- exchange rate,
- inflation,
- macroeconomic developments,
- volume of investment in the building materials industry,
- orientation of production to the domestic market,
- availability of domestic construction materials.

The non-market factors are the following:

- legislation,
- price regulation,
- policy rate change,
- tax regime change,
- price collusion,
- domestic producers' stimulation.

To forecast building materials prices, Liu et al. in addition to the abovementioned factors, also considered the impact of lending rate, money supply, and unemployment rate (Liu, Q.; He, P.; Peng, S.; Wang, T.; Ma, J. A. 2024). The other research investigated which factors significantly influence building material prices. The survey results show that according to respondents, cement, copper, and steel have the most volatile prices. The main determining factors were transportation cost, labor cost, and oil price, but market conditions, exchange rate, and import duties had less impact (Windapo, A. O., & Cattell, K. 2010). Meglin et al. show that a circular economy can buffer not only price volatility but also a secure supply of raw materials (Meglin R., Kytzia S., Habert G., 2022).

In research on the global building materials market, market observation is mainly carried out from three perspectives: building material type, end-user, and region (Fortune Business Insights):

- *By material type:* aggregates, bricks, cement, and metals;
- *By end-user:* residential, infrastructure, commercial, and industrial;

- *By region:* North America (US, Canada, Mexico), Europe (UK, Germany, France, Italy, Russia), Asia-Pacific (China, Korea, Japan, India, South-East Asia), Middle East and Africa (Saudi Arabia, Nigeria, Egypt and South Africa) and Latin America (Brazil, Columbia, Argentina).

Differentiating the determinants of building materials prices into global, local, market, and non-market categories provides a guideline for analyzing global and local building material market trends and influencing price behavior. The following sections will show these interactions.

RESEARCH METHODOLOGY. To analyze the global market of building materials, and to identify the main exporters and importers United Nations' Trade Statistics were used (UN Comtrade Database), which provide comprehensive statistics by product and trading partner. Data cover about 200 countries and represent over 99% of the world's merchandise trade. Also, the World Steel Association's World Steel in Figures data were used. Worldsteel represents steel producers, national and regional steel industry associations, and steel research institutes. Members represent around 85% of global steel production. For international price developments, data from the Federal Reserve Bank of St. Louis, Eurostat, the National Bureau of Statistics of China, and the World Bank were used.

The data were collected from official sources to analyze the developments and the determinants of construction prices in Armenia. Particularly, the construction prices are compiled by the RA Ministry of Finance by types of construction materials [1], which are then processed by the RA Statistical Committee to calculate a market price index. Other national statistical sources include the Central Bank of Armenia and the Cadastre Committee of Armenia.

It is important to note the distinction of price data used in the research. Specifically, the construction price index data for Armenia is calculated according to the price indexes of technological, and structural components of construction (construction and assembly work, capital investment in machinery and equipment, other operations and costs), weighted upon their shares in total volume.[2] In contrast, the US construction materials price index represents only materials costs. In some perspective, this difference could limit the direct comparison of these data series, as the data for Armenia have a broader coverage, rather than the US data. Taking into account this discrepancy, the analysis focuses on trends and correlations.

To analyze the determinants of construction prices in Armenia, the construction price index was modeled as a function of both demand-side and supply-side factors, where the specific indicators were selected based on the

[1] See https://minfin.am/hy/page/shinararakan_apranqatesakneri_gner/
[2] See https://armstat.am/file/article/gner_2024_10.pdf

literature review and the authors' expert judgment. Additionally, statistical and comparative analysis was employed to identify the structure and shifts in global markets and prices.

ANALYSIS.

Market structure. There are no unified estimates of the world market size for building materials. This problem is arising due to possible different methodological approaches and perspectives. Such evaluations are generally carried out on a bottom-up and top-down basis. Therefore, there may be gaps between the estimates due to the statistical data sample and market segmentation approach (segmentation by building materials used in residential and non-residential construction, segmentation by specific types, and geographic segmentation). This is exactly what reflects the market's peculiarity that the market's assessment depends on its micro-fundamentals. According to estimates, the global construction materials market size in 2023 is estimated from 1.3 to 1.9 trillion US dollars (Fortune Business Insights, Research, and Markets).

Driven by a large population, rapid urbanization, and extensive infrastructure projects, the dominant position in the global construction materials market belongs to the Asia-Pacific region. In particular, China, Japan, and India have experienced strong growth in the construction industry, boosting the demand for building materials. Meanwhile, the increase in investment in construction projects in the residential, industrial, and commercial sectors, together with initiatives by governments to develop infrastructure, have contributed to the formation of the dominant position of the Asia Pacific region in the global market. The next competitive market is the Middle East and Africa region due to investments in large-scale construction projects in the United Arab Emirates, Saudi Arabia, and Qatar.

In terms of application, the most common building materials are concrete, aggregates, bricks, as well as cement and steel. To describe the picture of the global market, in the framework of this research, we will focus on cement and steel prices, production, export, and import dynamics.

Looking at the export and import structure of the world market by country for two large groups of construction materials, we can notice that the structure in the dynamic picture has changed very little; only the proportions have changed slightly. Thus, China and Germany are the largest exporters of building materials, including stone, gypsum, cement, asbestos, mica, or similar materials, and the largest importers are the USA and Germany.

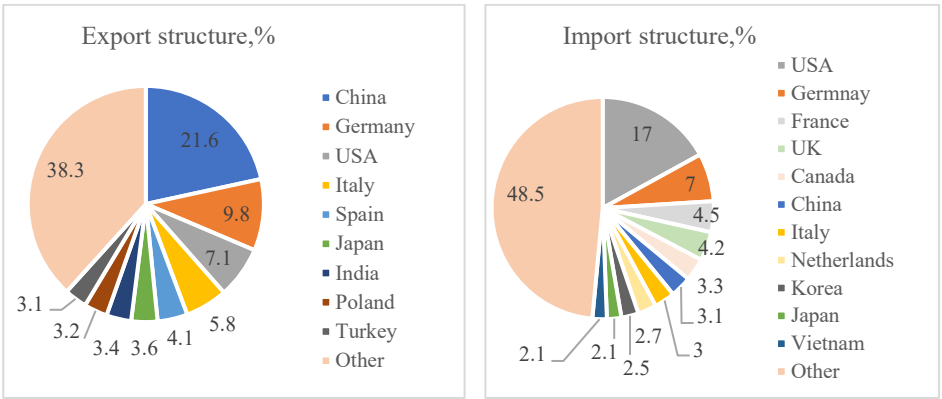

Figure 1. ***The geographical structure of the export and import of articles of stone, plaster, cement, asbestos, mica, or similar materials (HS code 68) in 2023, %***[3]

The volume of global cement production in 2023 compared to 2000 increased by 2.5 times, reaching 4.1 billion tons. Moreover, in 2023, 51.2% of global cement production was provided by China, 10% by India, 15.4% by Vietnam, USA, Iran, Turkey, Brazil, Indonesia, Russia, Saudi Arabia, and Egypt together, and the rest of the countries with smaller production. The global cement market in 2023 was estimated at 405.9 billion US dollars, and it is predicted that the global demand for cement in 2024-2030 will remain unchanged, except for the Middle East, India, and Africa, where faster growth will be recorded. The weakest cement markets are expected to be Turkey, China, and Europe.

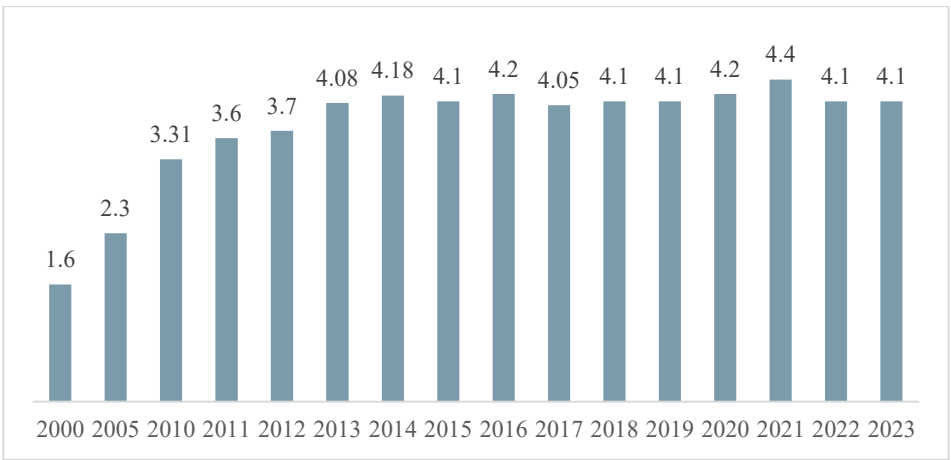

Figure 2. ***Volumes of global cement production, billion tons***[4]

The other considered type of building material is steel. In the world market in 2023 the largest share of iron and steel exports and imports belongs to China.

[3] Source: United Nations, Trade Statistics (UN Comtrade Database), https://comtradeplus.un.org/
[4] Source: https://www.statista.com/statistics/1087115/global-cement-production-volume/

As we can see from the chart, the top five exporting countries are China, Germany, Japan, Korea, and Indonesia, and in the import structure, China, USA, Germany, Italy, and Turkey.

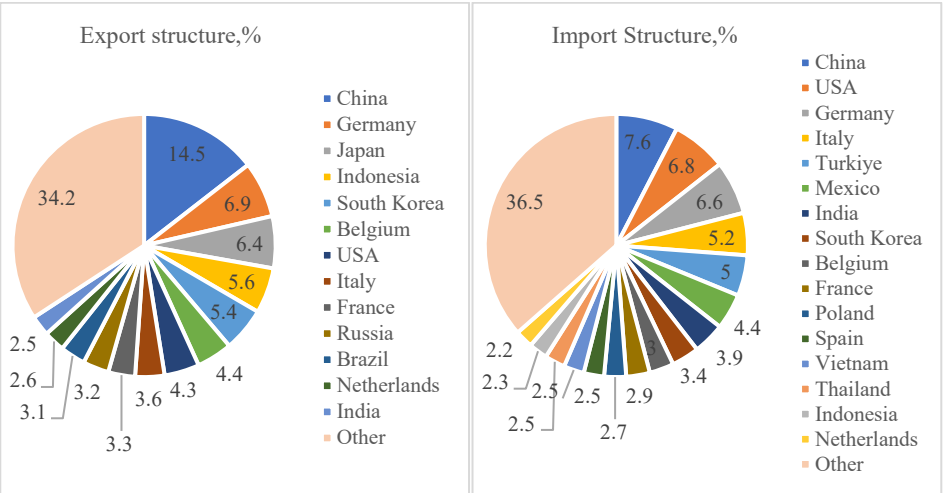

Figure 3. ***The geographical structure of export and import of iron and steel (HS code 72) in 2023, %***[5]

China is considered the leading producer and consumer of steel in the world market. In 2023, it provided more than half of world production; about 24% of steel production was provided by India, Japan, the USA, Russia, and South Korea. Germany, Turkey, Brazil, and Iran, which were included in the group of top ten producers, provided only about 7%. Many of the mentioned countries are also considered the largest consumers of steel.

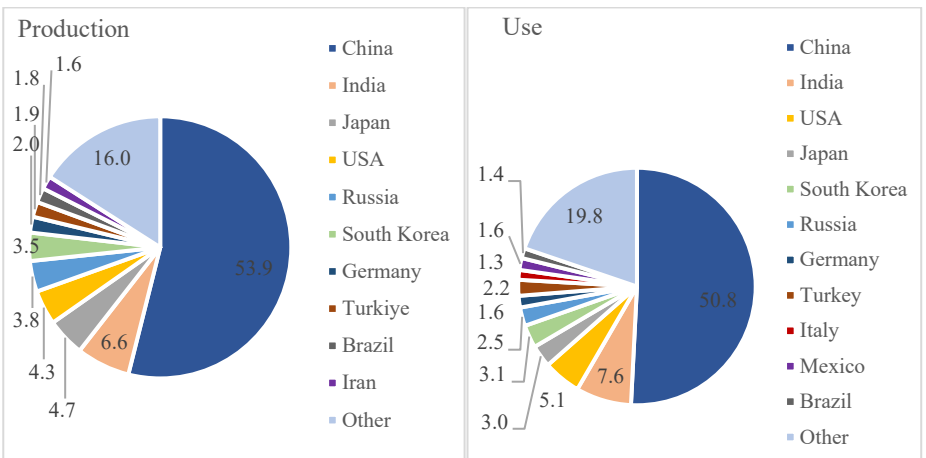

Figure 4. ***The production and use of steel by countries in 2023, %***[6]

[5] Source: United Nations, Trade Statistics (UN Comtrade Database), https://comtradeplus.un.org/
[6] Source: World Steel Association, World Steel in Figures

Cement, steel, and concrete have the most severe environmental burden during their manufacture (Huang B. et al. 2020). So, the new imperative that aims to cope with climate change has started to make certain structural shifts in the structure of the types of building materials used, bringing lighter, renewable, and environmentally friendly building materials to the fore. As a result, the "portfolio" of demand for building materials has been diversified. In the context of ensuring environmental protection and climate resilience, the use of higher-quality building materials has increased, particularly graphene, bioplastics, and light-generating concrete, which are more stable and durable[7].

This picture of the global market, its major market players, its economic development trends, and other economic and geopolitical factors influence the price developments of these building materials.

Price developments. There is no unified index of the international price of building materials. So, the international prices of the two types of construction materials discussed above, steel and cement, were considered for price development analysis. In particular, for steel, the indicators published by the London Metal Exchange (LME) of steel reinforcement bars were considered, which is regarded as a global benchmark. For the international price of cement, the combination of the price of cement and concrete in the USA was considered. As we can see, in 2020 after the pandemic shock, the prices of the mentioned building materials stabilized at a higher level compared to the pre-shock period. Another observation is that the price trend of building materials is comparable to the price of oil among energy carriers as a factor directly affecting the price.

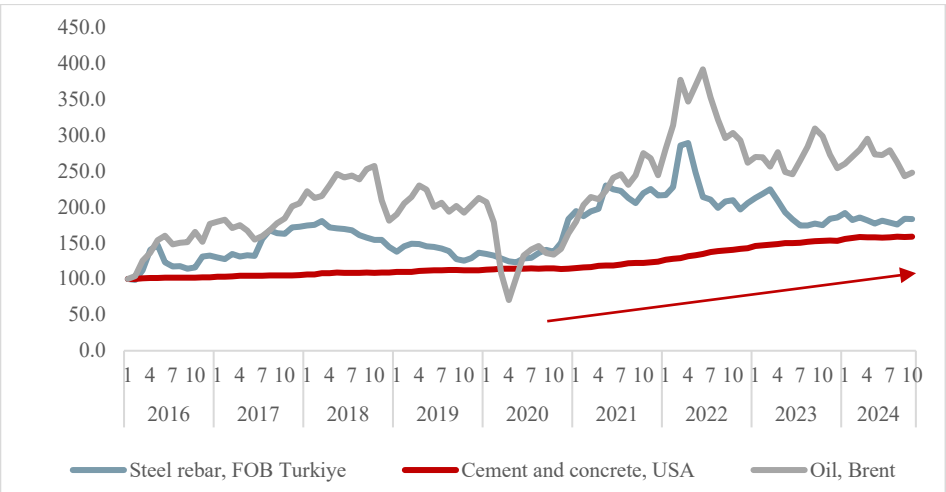

Figure 5. ***Construction materials and oil price dynamics (index, January 2016 = 100)*** [8]

[7] Source: https://finance.yahoo.com/news/building-materials-market-reach-usd-114000280.html

[8] Source: Federal Reserve bank of St. Louis, https://fred.stlouisfed.org/series/PCU32733273
Steel rebar futures LME, https://www.investing.com/commodities/steel-rebar
World Bank, Commodity Markets, https://www.worldbank.org/en/research/commodity-markets

From the chart, we can see that the price of cement had a steady growth trend. 2016-2019, the increase was due to the growing cement supply in the United States. Despite the pandemic shock that affected the construction sector due to reduced demand for non-residential buildings, the stability of demand for residential construction helped to prevent a sharp drop in prices. With lower interest rates and consumer confidence in the economy, cement and concrete prices have remained high. Due to inflationary pressures from 2022, the production costs of producers increased and stabilized at a fairly high level in 2024. As for the movement of the price of steel reinforcements and the factors determining it, let us note that it is sensitive to global supply and demand, raw material prices, and trade policy. In 2017-2018, due to the acceleration of global construction and production cuts aimed at reducing steel overcapacity, the prices of rebars recovered to some extent. However, due to pandemic realities, it has had volatile behavior since 2020. In 2021, prices rose sharply due to high energy prices and supply cuts. From 2022, the trend is declining. During 2024, the dynamics of international prices of rebars had the following picture: a certain stabilization of prices in Turkey was caused by the recovery of the demand of the European market, in particular, from Romania and Bulgaria. The instability of the real estate sector continues to be one of the main factors determining prices in China. There are concerns about developments in the Chinese market as a major global producer and consumer. It is associated with relatively weak demand, with excess supply resulting from previously high production levels, and weak demand stemming from weak developments in the construction and manufacturing sectors, resulting in downward pressure on prices[9].

Analyzing the index of the prices of construction materials in the USA, China, and the EU and looking at the price statistics in comparison, we can note that the prices of building materials in the USA are quite high compared to China, but the trends coincide in some periods. At the same time, it is necessary to state that the prices in the US and the EU after 2020 remain high after the pandemic shock.

In particular, disruptions in global supply chains and weak developments in the Chinese economy also had an impact on the price dynamics of construction materials, taking into account that the US imports some types of construction materials from China (for example, stone, gypsum, cement, asbestos, mica or similar materials for construction imports). China's share in the structure was 10.5% in 2023. Broader inflationary pressures were also contributing to higher material costs. The demand-side inflationary pressure was caused by robust demand for the construction of residential housing (rental and for sale), infrastructure projects, warehouses, and other logistics facilities.

[9] Source: https://www.reuters.com/markets/commodities/outlook-darkens-chinas-already-weak-steel-output-russell-2024-08-20/
https://www.cnbc.com/2024/08/21/the-worlds-largest-steel-industry-is-going-through-a-winter-amid-a-supply-glut-and-weak-demand-.html

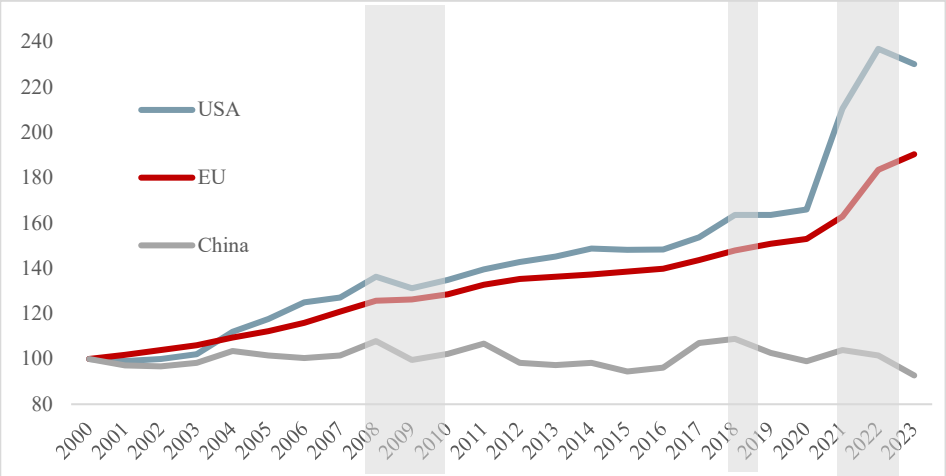

Figure 6. ***Dynamics of building materials price and construction cost indexes (2000 = 100)***[10]

The spike in construction costs in the EU started since 2020 and was also driven by supply chain disruptions and higher energy prices caused by the Russian-Ukrainian conflict, which hit the building materials market as these are energy-intensive industries. Another factor affecting construction prices was the lack of skilled labor. The low level of prices in China, especially in 2023, was caused by the reduction of exports of some building materials.

Dynamics of construction prices and explanatory factors in the RA. Developments in the construction industry are reflected in construction prices. As it can be seen from Figure 7, the sector's growth in recent years is combined with the trends of real estate prices and construction prices. Moreover, the growth of real estate prices began in 2018, while the growth of construction prices began with the general period of growth of prices (including consumer prices) in the economy from the end of 2020. Moreover, looking further back, we can notice that real estate and construction prices also increased during the boom period of the 2000s, indicating that price growth reflects not only supply but also demand factors.

[10] Source:` Federal Reserve bank of St. Louis, https://fred.stlouisfed.org/series/WPUSI012011
Eurostat` https://ec.europa.eu/eurostat/databrowser/view/sts_copi_q__custom_12602499/default/table?lang=en
National Bureau of Statistics of China, https://data.stats.gov.cn/english/easyquery.htm?cn=C01

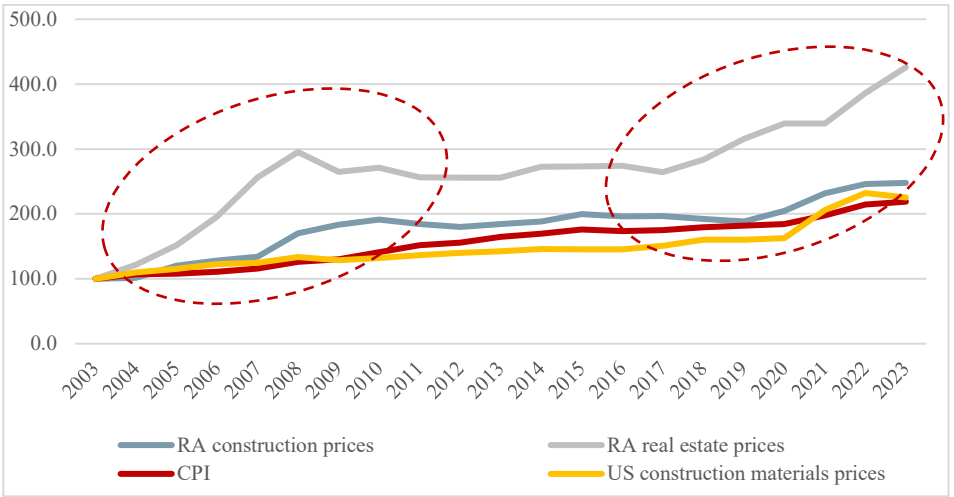

Figure 7. ***Construction and other price indexes, 2003=100***[11]

Since both import and local production are important for the construction sector in the RA, the variables of both groups were analyzed. Specifically, the prices of the globally representative US construction sector were considered as an external variable, and as local factors, the GDP gap, as an indicator of the economic cycle, and the industrial product price index were considered.

The estimated model is presented as follows:

$$CONSTR\_PRICE = 0.34*GDP\_GAP + 0.15*US\_CONSTR + 0.12*IND\_PR + 0.79*CONSTR\_PRICE\ (-1) - 7.71$$

Where:

CONSTR_PRICE is the y/y growth rate of the construction price index,
GDP_GAP represents the GDP gap estimated on the Hodrick-Prescott filter,
US_CONSTR is the y/y growth rate of US construction materials prices,
IND_PR is the y/y growth rate of the industrial product price index**.**

The model estimation results are presented below (Table 1).

[11] Source: CBA, Statistical Committee Republic of Armenia, Cadastre Committee of Armenia

Table 1

The assessment of the factors influencing the construction price index

Dependent Variable: CONSTR_PRICE
Method: Least Squares
Sample (adjusted): 2003Q2 2024Q1
Included observations: 84 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_GAP	0.336652	0.124434	2.705465	0.0084
US_CONSTR	0.155230	0.084627	1.834297	0.0704
IND_PR	0.118934	0.078021	1.524390	0.1314
CONSTR_PRICE(-1)	0.797957	0.078069	10.22123	0.0000
C	-7.715360	13.23031	-0.583158	0.5614

R-squared	0.641297	Mean dependent var	104.1274
Adjusted R-squared	0.623135	S.D. dependent var	8.313939
S.E. of regression	5.103873	Akaike info criterion	6.155555
Sum squared resid	2057.912	Schwarz criterion	6.300247
Log-likelihood	-253.5333	Hannan-Quinn criterion	6.213720
F-statistic	35.30947	Durbin-Watson stat	1.469528
Prob(F-statistic)	0.000000		

The model estimation results support the hypothesis that demand and supply factors affect construction prices. In particular, the effect of the GDP gap is significantly positive, with a 1% positive deviation of GDP from its trend leading to a 0.34% point increase in construction prices. Among supply factors, a 1% increase in industrial product prices leads to a 0.12% increase in construction prices in Armenia, and a similar increase in construction prices in the USA leads to a 0.15% increase. This positive correlation between the US and Armenian prices also highlights that construction prices in Armenia are aligned with the global market price trends. However, it is worth noting, that regardless of the difference in data coverage, which is in detail mentioned in the methodology, the trends in the US and Armenian markets are aligned. This indicates that global material price movements significantly influence local pricing. As it can be seen from Figure 8, the factors included in the model successfully explain the variation in construction prices, where actual and fitted values align closely, which indicates a good fit[12].

[12] One would expect, that the exchange rates would also play some role in explaining price dynamics, but the experiments with that variable did not yield a statistically significant results.

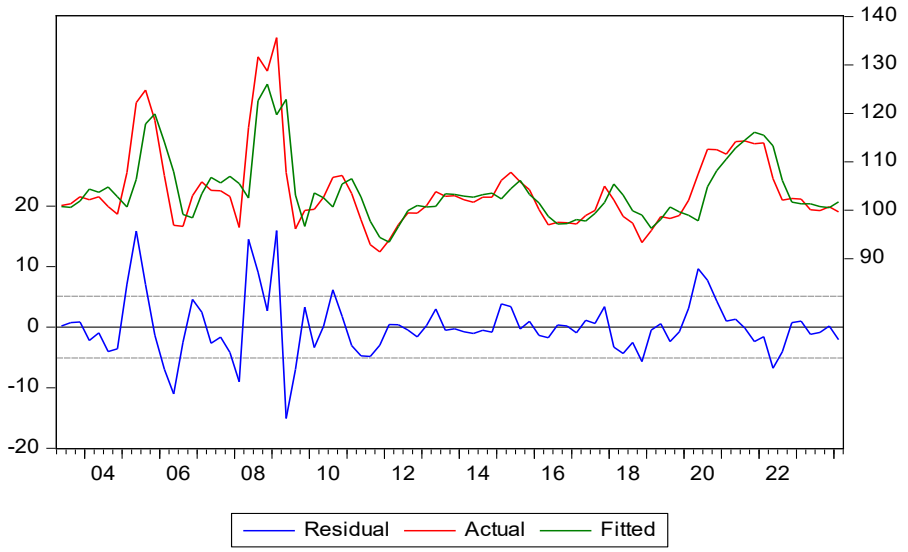

Figure 8. ***Explanatory power of the model***

CONCLUSION. The residential construction boom in Armenia in recent years coincided with a spike in real estate and construction prices, highlighting the critical role of understanding the drivers of those prices in understanding the market dynamics. The article analyzes the global market for construction materials, including its structure and trends, and determines the factors affecting construction prices in Armenia.

The analysis of the global market for building materials revealed that the global supply is relatively stable over time. Cement and steel are among the most used building materials, and China, India, Turkey, and Germany are major producers and exporters of cement worldwide. China is considered the leading producer and consumer of steel in the world steel market, followed by India, Japan, the USA, the Russian Federation, and Germany.

While the market structure may shift slightly, demand factors and short-term supply chain disruptions are the most critical price determinants. As China is a both major exporter and importer of building materials, its economic developments affect world price developments. Especially one of the factors affecting the domestic price of building materials in the USA is China's economic development. In recent years, the spike in prices was driven by the combination of several factors: the inflationary pressures arising from supply chain disruptions, an increase in energy prices, broad inflationary pressures, and robust demand for construction during the post-pandemic economic recovery.

The most important contribution of the article to the literature is the identification of determinants of construction price dynamics in Armenia. The analysis confirms that both demand and supply factors play a significant role in forming construction prices. Particularly, the construction price depends on the

GDP gap, US construction prices, and industrial prices in Armenia. This implies that the recent spike in construction prices can be explained both by the spike in global prices – driven by the overall inflationary environment of post-Covid times, and positive economic developments in the RA economy in recent years, which drove up the demand for residential construction and it had its inflationary effects for construction materials market.

One of the most important highlights of the research results is that the construction prices in Armenia can be explained and forecasted given realistic assumptions on respective external and domestic variables, which can be critical in business planning in the construction sector and also for the government policies targeting the sector.

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