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Thailand's Automotive EV Transition: Short-run Implications for Economic Growth

Xianguo Huang

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Prepared by Xianguo Huang[1] [2]

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Abstract

Thailand, Southeast Asia's leading automotive hub, is undergoing a structural transition from internal combustion engine vehicles to electric vehicles (EVs), driven by domestic industrial upgrading ambitions and global decarbonization pressures. While this shift is expected to support long-term growth and sustain export competitiveness, its short-run macroeconomic implications remain underexamined. This paper empirically assesses the automotive sector's contribution to GDP growth, using a composite activity index and interaction terms capturing the EV transition period. Results confirm that the sector remains macro-critical, with real GDP exhibiting statistically significant elasticity to automotive activity. However, this elasticity has weakened over time, and the EV transition is associated with additional short-run contractionary effects. These findings suggest that the accelerated pace of transition under the EV incentive policies may have amplified adjustment costs, highlighting the need for timely and inclusive policy responses to balance short-term dislocations with long-term structural transformation. At the same time, the transition presents a strategic opportunity to upgrade domestic capabilities and position Thailand as a competitive EV production hub in the region.

Keywords: Automotive, EV Transition, Industrial Policy, Thailand
JEL codes: L62, Q55, O25

[1] Author's e-mail address: jerry.huang@amro-asia.org. Xianguo Huang is a Senior Economist at AMRO. This paper was authorized for distribution by Abdurohman, Deputy Director.

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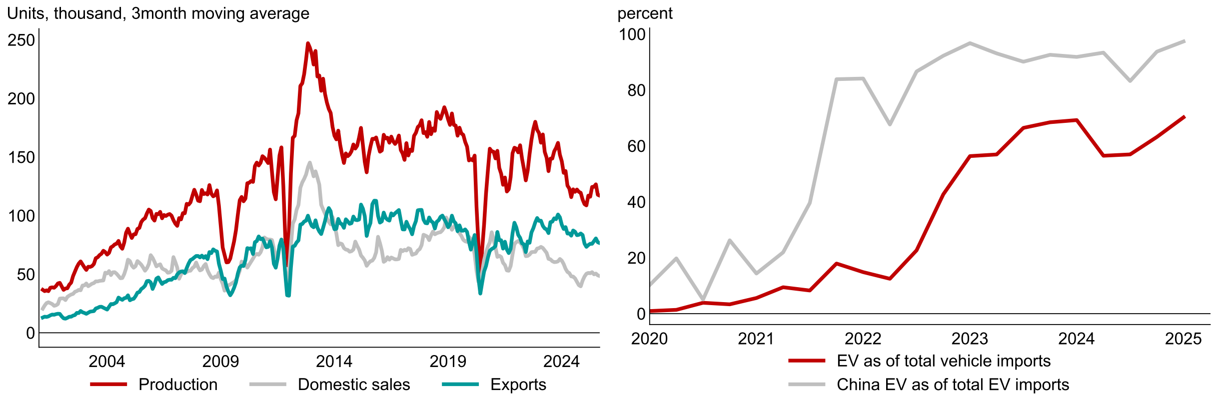
1 Introduction

Thailand has long been recognized as Southeast Asia's automotive hub, dating back to the late 1980s to early 1990s. In 2023, the country manufactured approximately 1.84 million vehicles and ranked as the world's ninth-largest vehicle exporter (Thailand Board of Investment 2023). The automotive sector contributes around 10–11 percent of Thailand's GDP, provides direct employment to about 850,000 people, and supports an additional 1.5 million indirect jobs (ASEAN Briefing 2024). However, the industry's recovery following the COVID-19 pandemic was slow, and it experienced another sharp downturn in 2024 (Figure 1a).[1]

Figure 1: Automotive Growth and EV Imports in Thailand



(a) Automotive

(b) EV imports

Thailand's automotive sector is undergoing profound change amid a broader structural transformation in the global automotive industry—namely, the accelerating shift from internal combustion engine (ICE) vehicles to electric vehicles (EVs). Globally, momentum behind EV adoption has surged. China leads the world, accounting for over 60% of global EV sales in 2023, followed by the EU and the U.S.. Several countries—including Norway, Germany, and the U.K.—have also announced plans to phase out new ICE vehicle sales in the coming years, reinforcing the global pivot to electrification (International Energy Agency 2024). Countries transitioning toward EV production have also been actively expanding exports amid increasing domestic EV adoption rates.

As a major auto manufacturing hub in the ASEAN+3 region, Thailand is undergoing this transition on both the production and consumption fronts. Although still at an early stage, the transition has gained momentum in recent years through targeted policy support. Thailand has embarked on a strategic shift to position itself as a key global EV production base, as envisioned in the 30@30 strategy.[2] Policymakers have introduced a range of measures to support this transformation and address

1. Total production dropped by 20 percent to a four-year low.

2. The 30@30 strategy aims for 30 percent of Thailand's total vehicle production to be zero-emission vehicles (ZEVs) by 2030.

emerging challenges, including EV tax incentives, investment promotion in advanced technologies, and trade facilitation, as elaborated in the EV 3.0 (announced in 2021) and EV 3.5 (introduced in late 2023) government EV subsidy programs (Table 1). These measures have helped accelerate domestic EV adoption, primarily through imports since 2022, and drawn foreign direct investment to establish production facilities (Figure 1b, 2a). Domestic EV production is expected to accelerate further in 2025 (Table 2).

The EV transition also presents structural challenges that could weigh on sectoral growth and have broader macroeconomic implications. Unlike ICE vehicles, EVs require significantly fewer parts, resulting in simpler and shorter supply chains (Kohpaiboon and Durongkaveroj 2024). Consequently, the shift is expected to reduce demand for traditional automotive components, posing transitional risks to Thailand's auto parts industry. The implications could be far-reaching, potentially leading to job losses, stranded capital, and valuation pressures across upstream and downstream segments of the sector.

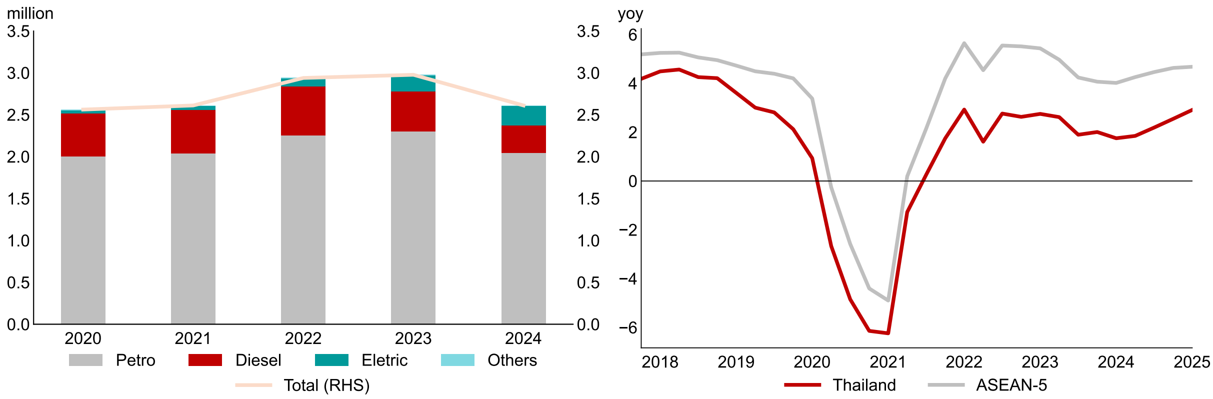
For instance, ICE-based production facilities may face difficulties in retooling for EV manufacturing, reduced demand for existing models, and the risk of stranded assets due to shorter-than-expected product cycles. At the same time, although charging infrastructure is expanding and consumer adoption is increasing, new EV manufacturers face challenges in meeting local production requirements amid soft domestic demand and intensifying external competition.

With domestic demand falling short of expectations—particularly in 2024—an oversupply of EVs has emerged, triggering sharp price competition. In 2025, with EV manufacturers that benefited from EV incentive programs required to meet local production targets, and as some ICE incumbents ramp up EV output in Thailand, market pressures are likely to persist (Table 2) although prices have stablized in recent months.

Difficulties in upgrading from a production base to an innovation base in ICE, as discussed by Intarakumnerd (2021), may continue to persist in an EV-dominant era. While Thailand has successfully attracted Foreign Direction Investment (FDI), developing indigenous EV-related technologies remains challenging, partly due to the lock-in effects within traditional Japanese automotive production networks, where the incentive to shift forward has been limited by sunk costs in older technologies (Intarakumnerd and Charoenporn 2024). In addition, the presence of free trade agreements (FTAs) may influence local capacity-building and business opportunities. Ongoing debates also highlight the need to balance technological upgrading with alleviating pressures on the existing ICE Vehicles (ICEV) industry. Kohpaiboon and Durongkaveroj (2024) argues that radical policy interventions at the expense of the ICEV industry could do more harm than good, while Kohpaiboon (2023) calls for a balanced approach—one that incentivizes EV adoption and supports industrial transformation, while accounting for technological uncertainties and the timing of capacity scale-up.

Opportunities and challenges in this sector are multifaceted, particularly in the context of green growth and transition policies. EV adoption can lower greenhouse gas (GHG) emissions by up to 70% in Thailand and significantly improve air quality (Khumpraphan 2024). Meanwhile, a significant share of EV-related employment could facilitate the adoption of Vehicle-to-Everything (V2X) technology and the integration of renewable energy into smart grids through V2X-enabled platforms (Wattana and Wattana 2022). Drawing on the case of India, Wattana and Wattana (2022) finds that decarbonization can reduce government revenue from and employment in traditional sectors.

Figure 2: New Car Registration and Real GDP Growth



(a) Newly registered (b) Real GDP Growth (4-period moving average)

Motivated by the transformation of Thailand's automotive sector—particularly since 2022—and its importance to the broader economy, this paper aims to quantify the sector's macro-criticality and assess the extent to which the transition from ICEVs to EVs poses short-run downside risks to economic growth. This inquiry is further motivated by the widening gap observed in GDP growth between Thailand and its peers in ASEAN during this period (Figure 2b). While a successful EV transition has the potential to enhance long-term competitiveness through technological upgrading and contribute to a greener economy, this study focuses exclusively on the short-run macroeconomic implications, incorporating both domestic and external factors into the analysis.

The remainder of the paper is structured as follows. Section 2 reviews recent trends in automotive production, domestic sales, exports, and investment. Section 3 evaluates the macroeconomic importance of the automotive sector and analyzes the short-run effects of the EV transition. Section 4 concludes with a discussion of policy implications and directions for future research.

Table 1: EV 3.0 and EV 3.5 Incentive Programs

Program Component	EV 3.0 (2022–2023)	EV 3.5 (2024–2027)
Duration	Subsidies for BEVs imported or produced in 2022 and 2023. Local production required by 2024 and 2025.	Subsidies from 2024 to 2027. Imports eligible in 2024 and 2025. Local production mandatory from 2026 onward.
Covered Vehicle Types	BEV passenger cars, pickups, and 2–3 wheelers (e.g., e-motorcycles, tuk-tuks).	Same types, plus commercial trucks and buses. Luxury cars priced at over THB2 million excluded.
Subsidy Amounts	THB 70k–150k per car (battery $>$30 kWh). Motorcycles: approx. THB18k.	THB50k–100k (2024, 10–50 kWh), THB35k–75k (2025), THB25k–50k (2026–2027). Motorcycles: approx. THB 10k. Local assembly required after 2025.
Import Duty Reduction	Up to 40% for EVs priced $\leq$ THB2M, 20% for THB2–7M. Not applicable to pickups or motorcycles.	40% for EVs $\leq$ THB2M (2024–2025). No reduction post-2025 or for vehicles $>$ THB2M, pickups, or motorcycles.
Excise Tax Reduction	Cars: from 8% to 2%. Pickups: from 10% to 0. Motorcycles: from 5–10% to 1%. Effective through 2023.	Cars $\leq$ THB7M: 8% to 2% (2024–2027). Pickups: 10% to 0% (2024–2025), 2% (2026–2027). Motorcycles: 5–10% to 1% (2024–2027).
Local Production Requirement	1:1 ratio of local BEVs per imported unit by 2025.	2:1 in 2026 and 3:1 in 2027. EV 3.0 quotas can be carried forward.
Battery & Product Standards	Minimum battery size of 10 kWh for subsidy eligibility. No requirement for local battery.	Battery size of 10–50 kWh for base subsidy; $>$50 kWh for full subsidy.
Manufacturer Eligibility	Open to importers via MOU. 14 participants by 2024.	Open to new and existing applicants with bank guarantees. Stricter production and tech criteria. No dual participation.

Sources: Thailand Board of Investment (BOI), various sources

Table 2: Announcements in Thailand's Automotive Sector (2024-2025)

Date	**Company**	**Investment Amount**	**Purpose**
March 2024	SVOLT	(not specified)	Partnership with Banpu Next to produce EV battery packs
March 2024	BMW	Over THB1.6 billion (EUR42 million)	Construct high-voltage battery assembly plant in Rayong for EV production, starting 2H 2025
May 2024	Toyota	Part of USD1.43 billion (THB50 billion)	Plan to manufacture electric Hilux by end of 2025
July 2024	Honda	Part of USD1.43 billion (THB50 billion)	Plan to consolidate production in Prachinburi for hybrid vehicles by 2025
August 2024	Hyundai	THB 1 billion (USD28 million)	Set up facility for EV and battery assembly (production starts in 2026)
January 2025	Great Wall	THB 25-30 billion	Expand to 150,000 units/year; focus on EVs and hybrids by 2025
January 2025	SAIC - CP	THB 60 billion by 2027-28	Target 300,000 units/year; include 150,000 battery EVs
January 2025	BYD	THB18 billion	Produce 150,000 EVs annually by 2024-25
January 2025	Neta	THB8 billion	Annual capacity of 50,000 units
January 2025	Hozon	THB8 billion	100% EV production
January 2025	GAC Aion	THB12 billion	Produce 50,000 EVs per year
January 2025	MG	THB5 billion	100% EV production
February 2025	Mazda	THB5 billion (USD150 million)	Produce electric compact SUVs; target 100,000 units/year for exports
March 2025	Changan	Exceeding THB10 billion	Start production of EVs in Thailand
March 2025	PPG	New plant, 2,000 tons capacity	Waterborne coatings manufacturing; support sustainable demand
March 2025	Sunwoda	More than USD1 billion	Invest in EV battery cell plants

Source: Various news sources and company announcements

2 Developments in the Automotive Sector

Thailand's automotive sector performance reflects a combination of cyclical fluctuations and deeper structural transformations. In the short term, weakening domestic sales, softening exports, and subdued investment signal mounting pressures on long-established manufacturers and the broader industrial base. These developments are unfolding alongside a more fundamental transition: the shift from ICEV to EVs. While EV models have begun to gain market share, the pace and structure of this transition carry significant implications for Thailand's competitiveness, supply chain integration, and macroeconomic resilience. This section reviews recent market dynamics and examines the ongoing transition from ICEV to EVs.

From a longer-term perspective, the Thai automotive industry transformed from an assembly-focused sector in the 1980s into a globally competitive production hub by the 2000s. On the consumption front, domestic automobile sales grew steadily over several decades, peaking in 2014. After a modest recovery in 2019, the downward trend resumed and has intensified since 2024. Pressures have been particularly evident among legacy players—primarily Japanese and American brands—that have long dominated the Thai market. In contrast, new Chinese entrants such as BYD have expanded their presence since 2023. According to newly registered vehicle data, the structural decline in conventional vehicles—despite a temporary cyclical rebound in 2022–2023—was reinforced in 2024. This recent contraction also marked a notable compositional shift: registrations of petrol and diesel-powered vehicles declined, while EVs—including battery electric, hybrid, and plug-in hybrid models—continued to grow, albeit from a low base.

Automotive exports have also faced increasing headwinds. While exports rebounded following the COVID-19 slump, momentum has weakened markedly since 2024. The stagnation has been most pronounced in assembled vehicle exports, with passenger car export values remaining flat over the past decade. However, growth in parts and accessories exports has helped cushion the overall decline. Investment in the automotive sector has also weakened and the decline in capital formation—particularly in traditional vehicle production—has been a notable drag on aggregate investment and growth, although it has been partially offset by rising EV-related projects.

Beyond macroeconomic and industrial indicators, data from publicly listed automotive companies offer additional perspective. On average, these firms have underperformed the broader stock market. Although aggregate industrial sentiment improved modestly in the second half of 2024 and into early 2025, subindices for the automotive and auto parts industries point to continued pessimism—particularly among ICE-focused producers facing structural headwinds.

3 Macro-criticality and the Effect of EV Transition

As discussed in the previous sections, the automotive sector is a major source of employment, stimulates private consumption through durable goods purchases, anchors substantial fixed investment, and is a key export industry. Given the sector's prominence in Thailand, we expect it to be macro-critical and aim to assess both its size and how its contribution has evolved over time. The ongoing EV transition—reflected in changes in production composition and rising domestic EV sales—raises important questions about whether the sector's contribution to the economy has been enhanced or diminished in the short run.

This section explores these issues empirically. We begin by estimating the elasticity of real GDP with respect to the automotive sector, using a baseline model that controls for key domestic and global macroeconomic factors. The sample is divided into sub-periods to assess changes in the strength of this relationship over time. We then extend the analysis by incorporating an EV transition dummy to evaluate whether the post-2022 shift toward EVs has amplified or moderated the sector's short-term impact on economic growth. The long-run effects of the transition are beyond the scope of the paper, however.

3.1 Model Specifications

The empirical analysis begins by examining the role of the automotive sector in driving overall economic activity. This is done using the baseline specification presented in Equation 1 below, which regresses real GDP on a set of automotive sector variables, along with relevant domestic and global control variables.

$$\mathsf{Y}_t = \alpha + \underbrace{\beta \mathbf{X}_t^{\text{auto}}}_{\text{Variable of interest}} + \underbrace{\Gamma' \mathbf{X}_t^{\text{d}}}_{\text{Domestic controls}} + \underbrace{\Delta' \mathbf{X}_t^{\text{o}}}_{\text{Other controls}} + \varepsilon_t \tag{1}$$

where:

- Y_t: Real GDP
- $\mathbf{X}_t^{\text{auto}}$: automotive sector activity
- $\mathbf{X}_t^{\text{d}}$: a vector of domestic macroeconomic control variables, including
  - consumer confidence
  - household debt-to-GDP ratio
  - interest rate
- $\mathbf{X}_t^{\text{o}}$: a vector of other control variables (global factors and COVID-19 dummy), which include
  - World real GDP

  - GFC dummy
  - COVID-19 dummy
- ε_t: Error term

This specification allows us to isolate the contribution of the automotive sector to overall output growth while controlling for macroeconomic fluctuations at both the domestic and global levels. Candidate variables capturing automotive sector activity include vehicle production, sales, and exports—each transformed into log-differences to address non-stationarity. Domestic controls account for household consumption sentiment and financial vulnerability, while global factors—such as external demand and oil prices—reflect broader international economic conditions.

To capture the evolving role of EVs and the structural transformation underway in the automotive industry, the baseline model is extended by introducing an interaction term between automotive sector activity and a time dummy variable indicating the accelerated EV transition period under government incentive programs. The extended model is specified as follows:

$$\mathsf{Y}_t = \alpha + \underbrace{\beta \mathbf{X}_t^{\text{auto}}}_{\text{Variable of interest}} + \underbrace{\theta(\mathbf{X}_t^{\text{auto}} \times \mathbf{D}_t^{\text{ev}})}_{\text{EV interaction terms}} + \underbrace{\Gamma' \mathbf{X}_t^{\text{d}}}_{\text{Domestic controls}} + \underbrace{\Delta' \mathbf{X}_t^{\text{o}}}_{\text{Other controls}} + \varepsilon_t \tag{2}$$

where additional variables:

- $\mathbf{D}_t^{\text{ev}}$: a time dummy variable capture periods of EV adoption accelerated by EV 3.0 and 3.5 programs
- $\mathbf{X}_t^{\text{auto}} \times \mathbf{D}_t^{\text{ev}}$: interaction terms capturing differential impact

This augmented specification in Equation 2 enables us to investigate whether the relationship between the automotive sector and economic activity differs during periods associated with accelerated EV adoption or shifts in consumer and production behavior. The coefficient on the interaction term (θ) provides insight into whether the economic contribution of the automotive sector is amplified or weakened in the context of the EV transition period.

3.2 Econometric Considerations

The model is estimated using Ordinary Least Squares (OLS) regression. To avoid spurious results, all variables are tested for stationarity. Non-stationary variables are treated using log-differences or first differences. Structural break tests are conducted to avoid bias, with additional GFC and COVID-19 temporal dummies included in the model specification. The COVID-19 shock is captured using the standard window of 2020Q2–2021Q1, while the GFC dummy covers the period 2008Q3–2009Q2.

As modeling the timing of the EV transition is critical for interpretation, the specification accounts for multiple dimensions of sectoral transformation. From a policy standpoint, the Thai Board of Investment (BOI) shifted its focus to battery electric vehicle (BEV) technology in 2020, announcing higher incentives for BEV project investments, which accelerated the development of domestic production capacity.[3] While government support for EVs began earlier, a key turning point came in 2022 with the rollout of the EV 3.0 subsidy scheme, marking the start of a structured incentive program targeting both consumers and manufacturers. This was followed by EV 3.5 in 2024, which further tightened local content and production requirements. A notable policy feature allowed major Chinese EV makers to begin selling imported BEVs while gradually ramping up local production, leading to a phased transformation in the structure of vehicle production and trade. This paper adopts 2022 as the starting point of Thailand's accelerated EV transition period, aligning with the implementation of incentive programs that catalyzed the shift, and capturing both policy-driven and market-led dynamics through 2024.

Selecting an appropriate measure to represent the performance of the automotive sector is nontrivial, given the multidimensional nature of its activities. To address this, we construct a composite AutoIndex $\mathbf{X}_t^{\text{auto}}$ using Principal Component Analysis (PCA) applied to three key monthly indicators: vehicle production, domestic vehicle sales, and vehicle exports. Each indicator reflects a distinct but interrelated dimension of the sector—supply, domestic demand, and external demand, respectively. Before applying the transformation, all series are converted into log-differences to capture short-run dynamics and ensure stationarity. We extract the first principal component, which captures the largest proportion of shared variance, and use it as a summary measure of overall sectoral activity. This approach reduces dimensionality while retaining the most informative combination of underlying indicators, thereby enhancing interpretability and minimizing noise.

Given the contemporaneous specification of the model, reverse causality is unlikely to be a major concern due to the timing of data construction and the use of transformed variables. All key regressors—including automotive production, domestic sales, exports, consumer confidence, and policy interest rates—are derived from monthly indicators available prior to the release of quarterly GDP data. As such, they reflect current economic conditions and are unlikely to be influenced by the GDP figures they aim to explain. Additionally, expressing regressors in log-differences or first differences helps eliminate mechanical identity-based endogeneity, particularly for sectoral indicators that may otherwise be components of GDP in level terms. Concerns about simultaneity—especially regarding interest rates and sentiment indicators—are further mitigated by the institutional sequencing of data: these variables are either policy-determined based on lagged information or collected independently prior to GDP release.

Beyond addressing reverse causality, omitted variable bias is mitigated through the inclusion of

3. EV policies were originally announced in 2017. The 2020 EV promotion package emphasized support for local battery production and included corporate income tax exemptions and customs duty reductions on imported machinery.

a comprehensive set of domestic and external covariates—including consumer sentiment, household indebtedness, policy interest rates, and global GDP growth—and statistical tests are conducted to confirm specification robustness. To ensure valid inference in the presence of heteroskedasticity and serial correlation, the model employs Heteroskedasticity- and Autocorrelation-Consistent (HAC) standard errors. Moreover, external regressors such as global GDP and oil prices are viewed as exogenous to Thailand's economic activity, consistent with its characterization as a small open economy. Collectively, these design features enhance the robustness of the model and support a causal interpretation of the estimated relationships between the regressors and GDP growth.

An overview of all variables used in the analysis—including their definitions, stationarity transformations, data sources, and coverage periods—is presented in Table 3.

Table 3: Variables in Use & Treatment for Stationarity

Variable	Description	Treatment	Data Source	Available Since
Y_t	Real GDP	Quarterly log-difference ($\Delta \log Y_t$)	National Accounts (NESDC)	1993Q1–2024Q4
$\mathbf{X}_t^{\text{auto,pd}}$	Vehicle production (in units)	Log-difference	Federation of Thai Industries	1991.1–2025.03
$\mathbf{X}_t^{\text{auto,ex}}$	Vehicle exports (in units)	Log-difference	Thai Customs Department	1991.1–2025.03
$\mathbf{X}_t^{\text{auto,sa}}$	Domestic vehicle sales (in units)	Log-difference	Toyota Motor Thailand	1991.12–2025.03
$\mathbf{X}_t^{\text{auto}}$	AutoIndex (PCA of production, sales, exports)	First principal component of log-differenced variables	Author's calculations	–
D_t^{ev}	Time dummy for accelerated EV adoption periods	Binary (1 if EV transition period)	Author's classification	–
$X_{1,t}^{\text{d}}$	Consumer confidence index	Log-difference	University of the Thai Chamber of Commerce	1998.10–2025.03
$X_{2,t}^{\text{d}}$	Household debt-to-GDP ratio	First difference (Δ ratio)	Bank of Thailand (BoT), NESDC, Author's calculations	2003Q1–2024Q4
$X_{3,t}^{\text{d}}$	Interest rate (BoT policy rate)	First difference (Δ rate)	BoT	2000.06–2025.04
$X_{1,t}^{\text{g}}$	World real GDP (trade-weighted)	Quarterly log-difference ($\Delta \log$)	Federal Reserve Bank of Dallas	1980Q2–2024Q4
$X_{2,t}^{\text{g}}$	Oil price (Europe Brent spot price, FOB, offshore)	Quarterly log-difference ($\Delta \log$)	Haver	1985.06–2025.04
D_t^{gfc}	GFC dummy variable	Binary (1 if GFC period)	Author's classification	–
D_t^{covid}	COVID-19 dummy variable	Binary (1 if COVID-19 period)	Author's classification	–

Note: All variables are expressed at a quarterly frequency. Vehicle production, domestic sales, and exports—originally available at monthly intervals—are aggregated to quarterly data by summation. Consumer confidence, the BoT policy rate, household debt-to-GDP, and oil prices are converted to quarterly frequency using simple averages. The common sample period spans from Q1 2011 to Q4 2024. Stationarity is assessed using the Augmented Dickey-Fuller (ADF) test.

3.3 Results

3.3.1 Baseline

As shown in Table 4, the empirical results underscore the significant short-run contribution of Thailand's automotive sector to economic growth. The coefficient on the AutoIndex variable $\mathbf{X}_t^{\text{auto, pc}}$, constructed using PCA from production, sales, and export indicators, is positive and statistically significant at 0.36. This suggests that stronger automotive activity is associated with faster real GDP growth.

Among the domestic control variables, changes in consumer confidence $(X_{1,t}^{\text{d}})$ are positively signed but not statistically significant, while increases in household debt-to-GDP $(X_{2,t}^{\text{d}})$ are negatively signed and significant at the 1% level, indicating a dampening effect on output. The coefficient on the Bank of Thailand's policy rate $(X_{3,t}^{\text{d}})$ is also negative, although not statistically significant. External demand, captured by world GDP growth $(X_{1,t}^{\text{g}})$, is positively and significantly associated with Thai GDP growth. As expected, the COVID-19 dummy variable (D_t^{covid}) is large, negative, and highly significant, indicating severe output losses during pandemic quarters.

The model demonstrates a good fit, with an adjusted R^2 of 0.86, indicating that the explanatory variables account for a substantial share of the variation in quarterly GDP growth. The F-statistic of 104 confirms joint significance. To ensure valid inference, the model is estimated using HAC standard errors. The Durbin–Watson statistic of 2.00 suggests there is no meaningful autocorrelation in the residuals.

Diagnostic tests support the robustness of the model. While the Omnibus and Jarque–Bera statistics indicate some deviation from normality, this is not uncommon in small-sample macro time series. HAC inference is used given that residuals show modest skewness and slightly elevated kurtosis. The relatively low condition number (18.3) indicates that multicollinearity is not a significant concern—an assessment further supported by the variance inflation factor diagnostics (Table A1). The RAMsey RESET test suggests that the model is correctly specified, with no major concerns regarding omitted variables (Table A2).

Table 4: Regression Results (HAC SE, 2003Q1–2024Q4)

Variable	**Coef.**	**Std. Err.**	**t**	**P-value**	**95% CI**
α	0.6790	0.122	5.579	0.000	[0.437, 0.921]
$\mathbf{X}_t^{\text{auto, pc}}$	0.3601	0.059	6.071	0.000	[0.242, 0.478]
$X_{1,t}^{\text{d}}$	0.0815	0.083	0.978	0.331	[-0.084, 0.247]
$X_{2,t}^{\text{d}}$	-0.2839	0.100	-2.849	0.006	[-0.482, -0.086]
$X_{3,t}^{\text{d}}$	-0.3273	0.230	-1.423	0.159	[-0.785, 0.130]
$X_{1,t}^{\text{g}}$	0.3173	0.113	2.810	0.006	[0.093, 0.542]
D_t^{covid}	-1.1499	0.291	-3.948	0.000	[-1.730, -0.570]
Model Statistics					
R-squared	0.872	AIC	207.0		
Adj. R-squared	0.862	BIC	224.1		
No. of Obs.	86	F-statistic	104.0		
Durbin–Watson	2.002	Cond. No.	18.3		
Omnibus	10.387	Prob(Omnibus)	0.006		
Jarque–Bera (JB)	10.737	Prob(JB)	0.0047		
Skew	0.709	Kurtosis	3.993		

3.3.2 Robustness Checks

To verify the stability and reliability of the baseline results, a set of robustness checks was conducted. These included (i) augmenting the model with additional global variables and time dummies, and (ii) re-estimating the baseline model using bootstrapped standard errors.

First, global oil prices $(X_{2,t}^{\text{oil}})$ were measured as the quarterly log-difference in Brent crude prices and added as an external control variable in alternative specifications (Alt. 1 and Alt. 3 in Table 5). The inclusion of oil prices is motivated by their potential impact on both global demand and domestic inflation expectations, which in turn may influence real GDP growth. The coefficient on the oil price variable is small but statistically significant at the 10% level, indicating a mild procyclical effect. Importantly, the coefficient on the AutoIndex variable $(\mathbf{X}_t^{\text{auto, pc}})$ remains positive, statistically significant at the 1% level, and similar in magnitude to the baseline, thereby confirming the robustness of the main finding. Other domestic and external control variables maintain their expected signs and levels of significance.[4]

Second, the robustness of statistical inference is tested by replacing HAC standard errors with nonparametric bootstrap standard errors based on 1,000 resampling replications. This approach provides a distribution-free estimate of standard errors and inference. As shown in the last column of Table 5, the AutoIndex coefficient remains highly significant under bootstrapping, reaffirming the core result. However, the COVID-19 dummy (D_t^{covid}), while still negative and large in magnitude, becomes statistically insignificant at conventional levels. Nevertheless, the main structural finding on the automotive sector's contribution to GDP growth remains robust across specifications and estimation techniques.

4. The inclusion of oil prices marginally improves model fit (adjusted R^2 remains stable, while AIC and BIC increase only slightly), but also raises the condition number from 18.3 to over 90, suggesting a potential rise in multicollinearity. This could be due to shared variance between oil prices and global GDP. Given its relatively weak explanatory power and potential to compromise model stability, global oil prices are excluded from the preferred specification in favor of parsimony.

Table 5: Robustness Checks of Baseline Model

Variable	Baseline	Alt. 1	Alt. 2	Alt. 3	Bootstrap SE
α	0.6790***	0.6987***	0.6933***	0.7028***	0.6790***
$\mathbf{X}_t^{\text{auto, pc}}$	0.3601***	0.3773***	0.3593***	0.3767***	0.3601***
$X_{1,t}^{\text{d}}$	0.0815	0.1043	0.0840	0.1046	0.0815
$X_{2,t}^{\text{d}}$	-0.2839***	-0.2459**	-0.2847***	-0.2468**	-0.2839***
$X_{3,t}^{\text{d}}$	-0.3273	-0.3236	-0.3665	-0.3358	-0.3273
$X_{1,t}^{\text{g}}$	0.3173**	0.2506**	0.3116***	0.2499**	0.3173*
D_t^{covid}	-1.1499***	-1.1822***	-1.1599***	-1.1848***	-1.1499
$X_{2,t}^{\text{oil}}$	–	0.0106*	–	0.0104*	–
D_t^{gfc}	–	–	-0.1879	-0.0584	–
Model Statistics					
R-squared	0.872	0.872	0.872	0.873	0.872
Adj. R-squared	0.861	0.861	0.861	0.861	0.861
AIC	207.0	207.0	208.8	208.7	207.0
BIC	224.1	227.2	228.4	230.8	224.1
F-statistic	104.0	98.8	103.0	97.9	104.0
Durbin–Watson	2.002	2.030	2.015	2.033	2.002
Cond. No.	18.3	84.3	19.8	92.0	18.3

Notes: Significance levels $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. “Bootstrap SE” uses bootstrapped standard errors for the baseline model (1000 resamples). Dashes (–) indicate the variable was not included in that sub-period.

3.3.3 Tests for Sub-sample Periods

To assess the evolving macroeconomic contribution of Thailand's automotive sector, the baseline regression is re-estimated across three sub-periods: 2003Q1–2015Q4, 2007Q1–2019Q4, and 2012Q1–2024Q4. These windows are chosen to capture dynamics before and after key policy and structural inflection points—including the Global Financial Crisis, domestic policy shifts, and the onset of the EV transition. Table 6 presents the coefficient estimates for the full sample alongside those for each sub-period.

Table 6: Regression Results: Full Period and Sub-periods

	Full Period	**Sub-periods**		
Variable	**2003–2024**	**2003–2015**	**2007–2019**	**2012–2024**
α	0.6790***	0.4344**	0.2831	0.7172***
$\mathbf{X}_t^{\text{auto, pc}}$	0.3601***	0.4216***	0.3791***	0.2902***
$X_{1,t}^{\text{d}}$	0.0815	0.0175	0.2171*	0.4334***
$X_{2,t}^{\text{d}}$	-0.2839***	-0.2345*	-0.2422**	-0.4510***
$X_{3,t}^{\text{d}}$	-0.3273	-0.5552*	-0.6990*	-2.4764***
$X_{1,t}^{\text{g}}$	0.3173***	0.7201***	0.8088***	0.0819
D_t^{covid}	-1.1499***	–	–	-0.6291***

Notes: significance levels $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. Dashes (–) indicate the variable was not included in that sub-period.

The coefficient on the AutoIndex variable ($\mathbf{X}_t^{\text{auto, pc}}$), which represents the elasticity of real GDP growth to automotive sector activity, shows a clear downward trend over time. In the earliest sub-period (2003–2015), the elasticity is estimated at 0.422 and is significant at the 1% level. This declines modestly to 0.379 in the 2007–2019 window, and further to 0.290 in the 2012–2024 period. All estimates remain significant at the 1% level. This gradual reduction suggests that while the sector retains macroeconomic influence, its short-run importance in driving growth has diminished over time.

Several structural explanations may account for this shift. First, Thailand's ongoing economic diversification, including growth in services and digital sectors, may have diluted the relative contribution of legacy manufacturing industries to aggregate output. Second, in the latest period, the transition from internal combustion engine (ICE) vehicles to electric vehicles (EVs) has likely introduced temporary frictions in production, supply chains, and investment cycles. Third, the entry of new players—especially foreign EV manufacturers—may have altered the sector's domestic value-added structure.

The sub-period analysis also reveals notable variation in other macroeconomic drivers. Consumer confidence ($X_{1,t}^{\text{d}}$), while insignificant in the full sample and early periods, becomes positive and statistically significant in the post-2012 period, indicating growing sensitivity of household behavior to sentiment amid economic and technological uncertainty. The household debt-to-GDP ratio ($X^{\text{d}}_{2,t}$) exerts a consistently negative and increasingly significant influence across all sub-periods—especially after 2012—highlighting the growing role of financial constraints in shaping near-term growth. Meanwhile, global GDP growth ($X^{\text{g}}_{1,t}$) maintains a positive and significant relationship with Thai output in the earlier periods, but its influence fades while including more recent periods. Overall, the sub-period results underscore a structural moderation in the automotive sector's short-run macroeconomic impact.

3.3.4 PCA AutoIndex and Decomposition

The constructed variable of interest, $\mathbf{X}_t^{\text{auto, pc}}$, is derived using PCA to capture the shared variation across core growth indicators in Thailand's automotive sector, as described in the earlier section. As detailed in Table 7, the PCA loadings, combined with the standard deviations of the underlying indicators, yield weighted contribution. Notably, the relatively higher weight on production suggests that fluctuations in output volumes account for a larger portion of the sector's short-term dynamics.

Table 7: PCA Details and Decomposition for Auto Sector Growth Rates

Component (i)	**PCA Loading** (w_i)	**Std. Dev.** (σ_i)	**Contriubtion** $\left(\frac{w_i \cdot \sigma_i}{\sum_j w_j \cdot \sigma_j}\beta\right)$
Production (pr)	0.6621	2.0139	0.1497
Sales (sa)	0.4511	1.6356	0.0828
Exports (ex)	0.5985	1.8980	0.1275

3.3.5 EV Transition

The baseline provides the analysis where the transition effects have been part of the changing elasticity of economic growth to the auto sector acitivities. In this section, a regression based on Equation 2—taking into account of EV transition seperately—is conducted and the result is shown in Table 8.

The regression results confirm the significant role of the automotive sector in supporting Thailand's short-run economic growth, consistent with the baseline in terms of direction. In terms of value, the coefficient on the AutoIndex $\mathbf{X}_t^{\text{auto, pc}}$ is bigger, taking the EV transition effect into consideration. The EV interaction term $\mathbf{X}_t^{\text{auto, pc}} \times D_t^{\text{ev}}$ is negative and statistically significant, suggesting that the GDP impact of auto sector activity was partially dampened during the examined transition period, potentially reflecting adjustment costs, structural reallocation, or transitional uncertainty during the industry shift. (Appendix Table A3 provides a list of potentail channels).

The control variables behave in line with macroeconomic expectations. Consumer confidence $(X_{1,t}^{\text{d}})$ is positively associated with growth, while increases in household debt-to-GDP $(X_{2,t}^{\text{d}})$ and monetary tightening $(X_{3,t}^{\text{d}})$ reduce GDP growth. Global economic conditions, captured by world GDP growth $(X_{1,t}^{\text{g}})$, exert a significant positive effect. The COVID-19 dummy (D_t^{covid}) is negative and significant, reflecting the contractionary effects of the pandemic.

The model demonstrates relatively strong statistical performance, with high model explanatory power and confirming the joint significance of regressors. Residual diagnostics suggest no serious issues: the Durbin–Watson statistic rules out strong autocorrelation; the Omnibus and Jarque–Bera tests show no significant deviation from normality; and the condition number of 34.8 indicates low multicollinearity. The use of HAC standard errors allowing up to two lags ensures robust inference in the presence of any autocorrelation or heteroskedasticity.

Table 8: Regression Results with an EV Transition Interaction Term

Variable	**2003–2024**		**2012–2024**	
	HAC	**Bootstrap**	**HAC**	**Bootstrap**
α	0.6319***	0.6319***	0.6713***	0.6713***
$\mathbf{X}_t^{\text{auto, pc}}$	0.3902***	0.3902***	0.3254***	0.3254***
$\mathbf{X}_t^{\text{auto, pc}} \times D_t^{\text{ev}}$	-0.3177**	-0.3177*	-0.2153**	-0.2153*
$X_{1,t}^{\text{d}}$	0.0802	0.0802	0.4226***	0.4226***
$X_{2,t}^{\text{d}}$	-0.2441**	-0.2441***	-0.3971***	-0.3971***
$X_{3,t}^{\text{d}}$	-0.3307	-0.3307	-2.3806***	-2.3806*
$X_{1,t}^{\text{g}}$	0.3247***	0.3247*	0.1007	0.1007
D_t^{covid}	-1.1711***	-1.1711	-0.6806***	-0.6806***

Notes: Significance levels $^{***}p < 0.01$, $^{**}p < 0.05$, $^{*}p < 0.1$. "Bootstrap SE" uses bootstrapped standard errors for the baseline model (1000 resamples).

It is not uncommon for the automotive sector to account for a significant share of GDP. For instance, Ballew and Schnorbus (1994) shows its impact on the U.S. economy is far bigger than the auto industry's share of total GDP. There are also a wide range of estimates on multipliers: the average multiplier in developed economies is around 1.5, and it is higher in automotive-intensive countries such as Germany, Japan, and South Korea, where average multipliers are approximately 3 (Saberi 2018). In the U.S., estimates suggest an upper bound of 4.2 (Alliance for Automotive Innovation 2025). These variations in multiplier effects are typically driven by structural factors such as supply chain complexity and domestic value addition, export intensity, and R&D investment, in which Thailand may exhibit relatively lower levels of sophistication compared to its peers.

4 Discussions

Thailand's automotive sector remains macro-critical, contributing significantly to aggregate GDP through output, investment, and trade. Econometric analysis confirms a positive and statistically robust relationship between activity in the sector and real GDP growth. However, this elasticity has declined over time—notably during the EV transition period.

The inclusion of an interaction term in the regression confirms that the sector's short-run growth contribution is significantly lower during this transition phase. This result is consistent across specifications and signals a structural recalibration of the sector's macroeconomic role. The weakening elasticity likely reflects transitional frictions related to evolving technologies—such as production retooling, supply chain downsizing and realignment, and the need to adapt infrastructure to new standards.

At the heart of this transformation is the shift from ICE to battery technologies, which are mechanically simpler, resulting in vehicles being less reliant on traditional tier-2 and tier-3 suppliers. These structural characteristics have weakened domestic value-added linkages and contributed to production dislocations—particularly among SMEs and workers with skills tied to legacy technologies.

That said, Given the nature of the transition, this disruption should be temporary, however. The short-run pain is also in part a function of the acceleration driven by the EV incentive packages. These programs have been successful in drawing FDI at a faster pace, particularly from Chinese automakers, which has also intensified near-term adjustment pressures on existing firms and workers. If managed poorly, these pressures risk undermining the sector's contribution to growth in the short run.

However, delaying the transition would be far costlier. In a rapidly evolving global market, the time window to establish a competitive EV ecosystem is closing quickly. A failure to act decisively could lead to the permanent loss of FDI and supply chain opportunities to more proactive regional peers, potentially resulting in a missed opportunity to the opportunities to secure the industry's long-term viability.

There are important implications for industrial and labor policy as well. While EV 3.0 and 3.5 have been effective in initiating and accelerating the transition, a more balanced and inclusive policy framework is needed to mitigate adverse side effects. Labor market disruptions and SME vulnerabilities must be addressed. Reskilling programs should be rapidly scaled to support displaced workers, while tailored financing and technical assistance can help SMEs adapt to new production technologies and standards.

To ensure long-term competitiveness, Thailand could pursue a strategic and coordinated policy agenda that links industrial upgrading with inclusive adjustment. This includes actively incentivizing domestic value creation in high-value segments such as batteries, power electronics, and automotive software—through joint ventures, upstream supplier development, and expanded R&D investment. At the same time, broader policy alignment is essential. Priority actions include scaling vocational and digital training, accelerating EV infrastructure deployment, and fostering innovation ecosystems that can anchor long-term productivity growth. Complementary fiscal measures—such as targeted green subsidies, public investment, and counter-cyclical support for affected workers and SMEs—will be critical to cushion near-term adjustment costs and crowd in private capital.

The EV transition marks a strategic inflection point. With timely, coordinated, and inclusive policies, Thailand can position itself as a competitive and sustainable EV hub in Asia. The challenge is not merely to adapt, but to capture a rapidly closing window of opportunity. Decisive action today will determine whether the sector regains momentum and evolves into a higher value-added growth engine—or risks stagnation amid global realignment.

5 Conclusion

In sum, Thailand's EV transition is not only a technological or industrial shift—it is a structural reconfiguration with macroeconomic consequences. While near-term frictions are evident, the long-term gains from securing investment, deepening value chains, and sustaining export competitiveness should not be underestimated. The challenge lies in managing the transition holistically—minimizing dislocations while enabling transformation. Policymakers should act decisively to anchor investor confidence, support labor and SMEs, and position Thailand at the forefront of Asia's green and sustainable industrial future. The success of this transition will ultimately depend on how swiftly and strategically Thailand turns disruption into opportunity.

A Appendix: Tables

Table A1: Variance Inflation Factor (VIF) Diagnostics

Variable	**VIF**
α	1.935636
$\mathbf{X}_t^{\text{auto, pc}}$	2.256225
$X_{1,t}^{\text{d}}$	1.529292
$X_{2,t}^{\text{d}}$	2.521228
$X_{3,t}^{\text{d}}$	1.076014
$X_{1,t}^{\text{g}}$	1.868542
D_t^{covid}	1.117537

Notes: VIF values of above 5 are generally considered indicative of multicollinearity issues.

Table A2: Ramsey RESET Test for Model Specification

Test	Result
F-statistic	1.2245
p-value	0.2996
Degrees of Freedom	$\text{df}_{\text{num}} = 2$, $\text{df}_{\text{denom}} = 77$

Regression

$$\mathrm{Y}_t = \alpha + \beta \mathbf{X}_t^{\text{auto}} + \Gamma' \mathbf{X}_t^{\text{d}} + \Delta' \mathbf{X}_t^{\text{o}} + \gamma_1 \hat{Y}_t^2 + \gamma_2 \hat{Y}_t^3 + \varepsilon_t. \quad (3)$$

where $\hat{Y}_t$ are fitted values from the original model.
Hypotheses:

$$H_0 : \gamma_1 = \gamma_2 = 0 \quad \text{(model correctly specified)}$$

$$H_a : \text{At least one } \gamma_i \neq 0 \quad \text{(model misspecified)}$$

Table A3: Potential Channels of EV Transition Effects

Category	**Effects**
Cons	+ lower operating and maintenance costs + enhanced user experience + reduced emissions and environmental benefits – increased strain on electricity grid and power infrastructure
Investment /Production	+ greenfield investments in plants, batteries, and charging infrastructure + crowding-in of private capital + shift toward higher value-added production – high transition and adjustment costs for firms – financial vulnerability for smaller or leveraged firms – short-term output disruption as ICE production declines – stranded assets and underutilized legacy plants – price war if EV production needs to meet government targets
Labor	+ new job creation in EV and battery manufacturing + opportunities for reskilling and upskilling – job losses in ICE-related segments – skills mismatch and regional displacement
BOP	+ increased export opportunities for EVs and components, replacing ICEVs + reduced oil imports dependence – rising imports of batteries and/or critical materials – exposure to critical mineral price volatility
Fiscal	+ potential revenue gains from EV-related industries – declining fuel tax revenues and ICE-realated revenue – high fiscal burden from subsidies and infrastructure investment

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Address: 10 Shenton Way, #15-08
MAS Building, Singapore 079117
Website: www.amro-asia.org
Tel: +65 6323 9844
Email: enquiry@amro-asia.org
LinkedIn | **Twitter** | **Facebook**