MANAGEMENT OF AGRICULTURAL LABOR RESOURCES AMID STRUCTURAL ECONOMIC TRANSFORMATION IN UZBEKISTAN (1991-2025)

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DOI : 10.67620/MMMjournal.33110001

Abstract. *The dissertation investigates the correlation between structural economic change and agriculture employment in Uzbekistan during the whole post-independence period (1991-2025). Descriptive, correlation, unit-root, cointegration, error-correction and structural-break analysis are employed using annual data from the World Bank on the employment share of agriculture and the GDP shares of industry and services in economies. Employment in agriculture dropped from about 39 to 25 per cent of all employment, with most of the loss occurring during the farm restructuring decade, between 2000 and 2009. In the long run, the services share of GDP is strongly, and the industry share moderately, negatively correlated with agricultural employment (β = -1.05) with the model explaining 75 per cent of the variance, but all series are I (1), no cointegration is detected and the adjustment is very slow (error-correction term = -0.071). An autonomous drift of -0.4 percentage points per year prevails in the short-run, which reflects both technological change and demographic shifts and migration-related exit, with Chow tests ruling out the stability of the parameters at the 2010 and 2017 levels. The pace of labor exit from agriculture decreased by two-thirds since the liberalization in 2017 paralleling the diversification of labor use into certain crops and the monetization of harvest labor and the monetization of harvest labor. The results paint a picture of tertiarization-driven, institutionally constrained, and partial externalization of Uzbekistan's transformation via migration, with relevance for rural labor policy and the Sustainable Development Goals.*

Key words: *Agricultural Management; Strategic Labor Management; Structural Transformation; Agricultural Employment; Institutional Reforms; Labor Resource Allocation; Economic Diversification; Uzbekistan.*

JEL Classification: *Q10; J21; O13; O14; M12*

INTRODUCTION

Uzbekistan became independent in September 1991 and found its economy to be designed almost exclusively to serve the need of the Soviet planning system. Agriculture led the production; not only that but cotton was dominant, and almost exclusively so in the case of cotton being produced in an irrigated plantation; the size of common farms was rather large, but industry was mainly upstream processing and machines related to the cotton complex; below all, cotton took the primary role in agricultural output and in exports and employment (Pomfret, 2006). Over one third of the labor force was on collective, state farm, and rural households relied not just on wages, but on housing,

services, and for social protection provided by the kolkhoz (Spoor, 1995). This economy then underwent a radical restructuring in the next 3½ decades. The contribution of services to gross domestic product (GDP) increased from about 27 per cent of GDP in 1991 to over 46 per cent by 2025, while the share of agriculture in the national labor force declined from nearly 40 per cent to about 25 per cent (World Bank, 2025a). This dissertation analyzes their linkage between these two processes: how structural economic change reflected by the sectoral re-structuring of Uzbekistan GDP has affected on agricultural employment in the country during 1991-2025.

Uzbekistan's path of transition was peculiar. Instead of rapid liberalization, the government led by Islam Karimov pursued a slow-paced gradualist approach of import-substituting industrialization, demanding state orders in cotton and wheat with a view of controlling foreign exchange and gradually selling the state assets. (Zettelmeyer, 1999; Ruziev, Ghosh and Dow, 2007) A relatively mild transition recession for the region was the outcome, as were the administrative redirection of resources out of agriculture into more likely economic industrial growth areas, which was extended for a long period for the region. The second phase started in 2016, following the policy switch of the government of President of Uzbekistan - Mirziyoyev Shavkat Miromonovich towards liberalizing in the country: changing the exchange rate, ending the state-order system for cotton, ending compulsory labor during the cotton harvest and opening up the country to trade and investment (World Bank, 2022; ILO, 2022). The 1991-2025 period is thus a particularly informative "natural experiment" for analyzing the effects of structural change on rural labor markets, as it covers two different policy environments.

1.2 Agricultural transformation, employment and rural livelihoods

It was also in stages that the agricultural sector itself was transformed in the 1990s, when a shift from collective farms to shirkers was made, and at the dawn of the twentieth century when the collective farm system was reorganized and individual dehkan (farmer) plots and leasehold private farms officially emerged (Ilkhamov, 1998; Lerman, Csaki and Feder, 2004; Djanibekov et al., 2012). Every reform wave contributed to shifting the demand for labor. Diversification from sufficient seasonal field labor for cotton towards the mechanization of this labor has introduced new, more intensive labor opportunities, particularly in the horticulture sector since 2017 (World Bank 2019). During the same period, the rural economy shifted its weight away from agriculture: small-scale trade, construction activities and especially the migration of labor to Russia and Kazakhstan played a major role in the rural settlement's income structure (Seitz 2019). An interpretive question of this study is whether the number of agricultural jobs is declining due to a healthy shifting of labor to other sectors that are more productive, or due to distress and triggered exit from a dreary countryside.

1.3 Economic diversification and sustainable development

The question also is directly related to the concept of sustainable development. Decent Work in Agriculture and the orderly movement of labor out of low productivity agriculture support multiple UN Sustainable Development Goals particularly those of Zero Poverty (SDG1), Zero Hunger and Sustainable Agriculture (SDG2), and Decent Work and Economic Growth (SDG8) (United Nations, 2015; FAO, 2017). In a lower-middle income country where half the population is still in rural areas, the nature and degree of structural change is the main factor in deciding the inclusiveness of growth, a process largely influenced by accelerating rural-to-urban migration (World Bank, 2022). The broad outlines of the period investigated are summarized in Table 1.1.

Table 1.1 *Structural change and agricultural employment in Uzbekistan, period averages, 1991-2025*

Period	Agricultural employment (% of total)	Industry value added (% of GDP)	Services value added (% of GDP)
1991-1999	38.8	27.2	33.6
2000-2007	33.7	22.8	37.8
2008-2016	27.5	24.3	42.4
2017-2025	26.4	30.0	41.6

Note. Author's calculations from World Bank (2025a, 2025b, 2025c) data; ILO modelled estimates.

LITERATURE REVIEW

Theoretically, it stands on the classical legacy of the dual economy tradition. Lewis' theory (1954) stated that development occurs in stages by transferring labor from the low productivity "subsistence" sector to the high productivity capitalist sector until the surplus labor is cleared up, and the agricultural wage sets urban wages. Ranis and Fei (1961) postulated a sequential model, whereas Jorgenson (1961) went with a neoclassical one that replaced the concept of additional labor with food demand. Both these models had been linked to the empirical regularity that Kuznets (1973) and Chenery and Syrquin (1975) observed: that agriculture's share of output and employment decreases as per capita income increases, industry expands and eventually flattens, and services expand continuously as income rises. Some later contributions broke down the mechanisms. Agricultural productivity growth could have an opposite impact on labor mobility from farming - spurting the labor force out of agriculture in closed economies - or a similar impact - keeping the labor force in farming in open economies with comparative advantage in agriculture, as Matsuyama (1992) demonstrated directly for a cotton exporter like Uzbekistan. The pull of non-agricultural technology has prevailed in the past as found by Alvarez-Cuadrado and Poschke (2011), and Ngai and Pissarides (2007) and Herrendorf, Rogerson and Valentinyi (2014) distinguished channels of change through relative prices, from channels of change through differential product growth.

These were derived from the sectoral taxonomy which first came into use because Fisher (1939) and Clark (1940) systematized the primary-secondary-tertiary taxonomy; a complementary mechanism to tertiarization was provided by Baumol (1967) who found that in many services productivity growth is slow by nature, in which case the employment share increases even if the share of demand does not change, the 'cost disease' model. Gollin, Lagakos and Waugh (2014) argue that there is a compelling measurement reason to account for labor exit, as they show very high value added per labor hour differentials between agriculture and other sectors in the after-tax world, showing strong potential for reallocation gains.

This literature is largely unanimous that agricultural employment decrease is a common finding for development (Timmer, 1988; Gollin, 2010). Disagreements are about cause and well-being. Johnston and Mellor (1961) and Timmer (1988) think that agricultural productivity growth is necessary if Africa and Latin America are going to have healthy transformation, but McMillan and Rodrik (2011) point out that in their regions, labor relocated from agriculture to less productive informal services - "growth-reducing" structural change. Furthermore, late developers are subject to "premature deindustrialization", which Rodrik (2016) argues has been closed off also for the earlier industry developers. What is good about this body of work is its well-defined analytical framework and comparative evidence of a long-term nature, weaknesses are just as apparent. It is typically assumed that jobs are freely bid for and available, and labor is freely mobile, which is not the case in

economies where government allocation of labor takes place, in which labor has to be registered for jobs in residence and in which harvest labor is compelled and involuntary - features of post-Soviet Uzbekistan. Furthermore, international migration is a first-order mode of labor mobility in Central Asia, and the canonical two- and three-sector models ignore this aspect, which is neglected across the developing world. In addition, the canonical two- and three-sector models do not explicitly account for international migration, which in Central Asia is a primary channel through which labor mobility occurs and which is ignored throughout the developing world. Overall, the structural transformation theory offers the hypothesis, which states that, in an industrializing economy, an increase in industry and services should be tied with a decrease in agriculture employment shares, but its mechanisms can't be taken for granted in an economy making a transition; they need to be tested.

2.2 Cross-country empirical evidence on sectoral change and agricultural employment

There is a wide empirical literature that measures the transformation regularities. Duarte and Restuccia (2010) break down convergence in productivity by economy into two components to describe the contributions of both divergence and convergence. Some authors reveal that low agricultural productivity reduces the likelihood of starting industrialization (Gollin, Parente and Rogerson 2002) and that agricultural improvement is not equally beneficial for reducing poverty for the poorest (Christiaensen, Demery and Kuhl 2011), respectively, suggesting that a rapid exit from agriculture is not always an improvement in welfare when it's accompanied by less progress in productivity. Matching conventional soy (labor-pushing) with modernizations to maize (land-pushing), Bustos, Caprettini and Ponticelli (2016) show that the factor bias of agricultural technical change determines whether agricultural modernizations release or absorb labor from the sector x-where soy modernizations released workers, whereas maize modernizations absorbed workers. This discovery is particularly relevant to the situation of Uzbekistan, as mechanization of cotton production is labor-saving, and diversification of its agriculture into horticulture is labor consuming.

Methodologically, these studies are well done regarding identification compared to the older correlational literature - Bustos et al. (2016) take advantage of exogenous technology shocks, and decomposition analysis by McMillan and Rodrik (2011) has decomposed within-sector productivity growth from between-sector growth. For the purposes of this study their only weakness is external validity, as no analyses cover Central Asian economies, which present a combination of administered agriculture, resource rents, and mass emigration that sets them apart qualitatively from the countries of Latin America and Africa analyzed. Another type of cross-country studies, for example by Herrendorf et al. (2014), likewise smooths out the variation across policy environments, concealing exactly the policy regime changes as Uzbekistan liberalized in 2017 that time-series analysis can uncover. The mini-conclusion is the following: the empirical transformation literature provides important, stylized facts as well as useful mechanisms but largely fails to stretch to an examination of the transition-economy variant of the process, let alone Uzbekistan.

2.3 Agrarian transition in post-socialist economies

There is a unique literature about agricultural transition from plan to market. Macours and Swinnen (2000) point to the collapse of output in the post-1990 transition economies as due to the effects of price liberalization, removal of subsidies and disturbance of exchange relationships, whereas Rozelle and Swinnen (2004) make a similar argument for the combination of macro stabilization, hard budget constraints and - crucially - secure individual land rights. Individualization of farm organization was shown by Lerman, Csaki and Feder (2004) to be associated with gain in productivity where it occurred, and by Lerman (2009) to have resulted in faster recovery for Central

Asian countries allocating land to households than to those that left the large-farm structure intact. Variance in initial conditions and in technology (capital versus labor intensive farming) is brought together with Swinnen and Rozelle (2006) into a political-economy explanation where technology creates optimal reform routes.

There are significant points of agreement: almost all authors agree that the performance of agriculture post transition was greatly affected by the reform of the rights over land and prices. There are also some differences in sequencing, and the job effects of restructuring. The emphasis is on the efficiency gains component of labor shedding in the work of Rozelle and Swinnen (2004); in the agrarian political-economy analysis of the social costs of labor shedding by rural workers from farm jobs who did have alternatives, Stress lies with the authors of Spoor (1995) and Kandiyoti (2003). Literature notes that there was a lot of reliance on comparative case narrative, and that the farm-level surveys employed were of variable quality, and the official employment data from the 1990s were weak (Pomfret, 2006). Few studies use formal time-series econometrics, mainly because there were not yet extended time-series of post-independence long enough. The same constraint is no longer in force: thirty-five annual observations are available for Uzbekistan, but the econometric opportunity has hardly been developed. This is element number one with respect to the research gap.

2.4 The Uzbek case: cotton, farm restructuring and rural labor

Scholarship is divided into three lines pertaining to Uzbekistan. The first has to do with the macroeconomic strategy. It was Zettelmeyer (1999) who formulated the “Uzbek growth puzzle” (decline in output was below the prediction of transition models) and blamed it on the base effect of cotton exporting and gold export, energy self-sufficiency, and gradualism. Ruziev, Ghosh and Dow (2007) returned to the puzzle and made this point: the gradualist approach created build-ups of distortions, and importantly, in the foreign-exchange system, that led to private investment being inhibited. It was also strongly summarized by Spechler (2008) that the Karimov model was also politically stable, but allocatively inefficient. Findings taken from these accounts are in congruence about the implicit taxation of agriculture resulting from Guadagni et al. (2005) estimation of significant transfers from farmers to the state via depressed procurement prices and over-priced exchange rate under the state-order system in cotton. A similar comparative logic complements Pomfret (2000), by raising the question of why the forthcoming liberalization of household plots in Uzbekistan did not bring with it the same productivity miracle that China experienced and why the Chinese policy of retaining their own procurement quotas eliminated the incentive effects. There is an important implication for the employment of workers in agriculture: agriculture became economically unattractive even as most workers remained formally recorded within it - a clear mismatch between formal status and lived reality.

The second strand relates to restructuring the farm(s). Relatively little has been written about the conversion of kolkhozes into shirkats, which was mostly described as "cosmetic" (Ilkhamov 1998), and was not a uniform process but varied by region, as documented for Khorezm, subject to the state's continuing cycles of consolidation, fragmenting and reconsolidation of private farms (Veldwisch and Spoor 2008), and occurred in multiple forms with strongly gendered effects (Kandiyoti 2003), and persisted through a complex series of de-consolidating and re-consolidation cycles in the control of the state (Djanibekov et al. 2012). Trevisani (2010) provided rich ethnographic evidence that demonstrated that “private” farmers continued to be subjected to district authorities. Subsequent studies (Lerman, 2008; World Bank, 2019) confirmed improved productivity because of individualization, and continued limitation of choice and land markets. The third strand relates to

labor in the cotton economy, specifically the mobilization of the student body, public servants and rural communities for the harvest, and the eventual phasing out of such labor: ILO third-party monitoring found that systemic forced labor was no longer observed during harvest 2021 (ILO, 2022), a shift in the institutional arrangements which has direct implications for measured agricultural employment.

The achievements of Uzbek literature are institutional richness and depth of field; there is a pool of researchers that take up mechanisms that are not visible from macro data like Kandiyoti (2003) and Trevisani (2010). It has three major drawbacks. On the quantitative side there is a shortage of contributions, since existing studies are only at farm or regional level which are at farm or regional level, not national level (Guadagni et al., 2005; Djanibekov et al., 2012). Second, most of it has been dated to before 2017, so that econometric literature barely discusses the transformative Shavkat Mirziyoyev reforms, such as the exchange-rate unification, the prohibition of the state order, forced labor, the cluster-based cotton privatization, and the promotion of horticultural export. Third, any study that relates the share of GDP of each sector to agricultural employment on the full independence period has not been identified. The mini conclusion is that agricultural employment might decline but from the Uzbek literature it is not possible to quantify how much of the evolution has its roots in structural change.

2.5 Migration, the rural non-farm economy and livelihood diversification

A final theme relates to the exit of the labor force from agriculture. Global evidence reviewed by Haggblade, Hazell and Reardon (2010) and Davis, Winters and Carletto (2010) indicate that non-farm income typically accounts for between 35 and 50 per cent of rural household income in developing countries and could be motivated by accumulation (“pull”) or distress (“push”). In Uzbekistan, Ajwad et al. (2014) report low formal employment creation and high skills mismatch, and Seitz (2019) provides evidence of the strong impact of international remittances on the welfare of households, with a significant share of remittent coming from Russia and a rural concentration. Given that farm productivity is low, agricultural success continues to be the strongest tool at the disposal of least developed nations to reduce poverty (De Janvry and Sadoulet 2010), and the poverty reducing impacts of emigration depend upon the characteristics of the migrants' job (Christiaensen et al. 2011) pointing to emigration-led exit being a second-best transformation path. The advantage of this strand is that it is household level granularity and has a focus on welfare issues; the drawbacks are that the design is cross-sectional which is unable to capture dynamics and no study within the strand relates the diversification behavior of households to the economy-wide sectoral changes that transformation theory considers basic. The interpretation of the under-employment of agricultural workers across the strand is largely a matter of perspective: whether the under-employment of agricultural laborers is evidence of a successful domestic structural transformation (Lewis perspective) or that the surplus agricultural laborers have been exported from the country (migration perspective). The limitation of the national accounts, which the present study accepts, is that it is hard to separate out the two readings, while the time-series analysis can at best formulate a question concerning the statistical relationship between domestic sectoral growth and agricultural labor forces retirement, which is a necessary condition for the first interpretation. The mini conclusion is that livelihood research tells us where labor goes when it leaves the lifeworld, but it does not tell us what are the structural forces that push the labor to leave the lifeworld. That is, this dissertation investigates the structural forces that push the labor to leave the lifeworld.

2.6 Comparative Central Asian evidence and measurement debates

The best way to understand the situation in Uzbekistan is to consider how it differs from its neighbors on the path of reform. Kyrgyzstan gave out land to household units ahead of schedule, and spearheaded remobilization of human resources to smallholder agriculture during the 1990s collapse; Kazakhstan is very capital-intensive and large landholder agriculture rapidly released agricultural labor; Tajikistan, a cotton economy, experienced slow agricultural reform and mass emigration, making it one of the world's most remittance-dependent economies. This is a comparative variation, in support of Swinnen and Rozelle's (2006) contentions that initial conditions of technology and factor endowments shape the labor outcome of equivalent-sounding policy reforms, and against generalizing results from one region to another. The high rural density, substantial reliance on irrigation, and the most enduring system of state-ordering found in Uzbekistan suggests that it makes the strongest case for single-country analysis, rather than a regional pooled regression whose institutional record would differ from what is hypothesized.

A further, often overlooked, issue concerns measurement. The long time-series variable available is an ILO modelled estimate of agricultural employment, produced by a model-based interpolation of heterogeneous national sources. It has long been recognized by scholars of Central Asia that in the 1990s labor statistics obscure the formal employment on farms and the other two types of labor - household-plot and unpaid family labor - creating a classification difficulty (Pomfret, 2006), and that before 2017 labor was mobilized to work in formal agriculture on farms while all the other types of labor work, particularly planting and harvesting, were carried out on the household plots and for unpaid family labor, thus removing these de facto labor activities from de jure agriculture (Kandiyoti, 2003; ILO, 2022). Few empirical papers address the implications for econometric work: measurement error which is correlated with the policy regime will lead to a biased relationship, and this measurement error can appear as a 'structural break'. Although the present study cannot remove the problem, it tries to tackle the issue more openly than the literature, by testing for breaks and interpreting such coefficients as associations within the measurement system.

2.7 Synthesis and research gap

Table 2.1 integrates the main contributions covered and Table 2.2 provides a comparison of the methodological approach of the strands.

Table 2.1 *Synthesis of key literature*

Study	Context	Method	Key finding	Limitations
Lewis (1954); Ranis & Fei (1961)	Theory	Dual-economy models	Surplus labor transfers out of agriculture as modern sector grows	Assumes free labor mobility; no migration channel
McMillan & Rodrik (2011)	Cross-country	Productivity decomposition	Structural change can be growth-reducing	No Central Asian coverage
Bustos et al. (2016)	Brazil	Quasi-experimental	Factor bias of farm technology determines labor release	External validity to administered agriculture unclears
Rozelle & Swinnen (2004); Lerman et al. (2004)	Transition economies	Comparative institutional	Land rights and liberalisation drive recovery	Employment effects secondary; little econometrics

Study	Context	Method	Key finding	Limitations
Zettelmeyer (1999); Ruziev et al. (2007)	Uzbekistan macro	Growth accounting/narrative	Gradualism cushioned output, stored distortions	Agriculture treated in aggregate
Kandiyoti (2003); Trevisani (2010); Djanibekov et al. (2012)	Uzbekistan agrarian	Fieldwork/case study	Restructuring reallocated labor and risk to households	Local scale; pre-2017
World Bank (2019, 2022); ILO (2022)	Uzbekistan reform era	Policy analysis	Post-2017 reforms transformed cotton labor institutions	Descriptive; not peer-reviewed econometrics
Seitz (2019); Ajwad et al. (2014)	Uzbekistan labor	Household surveys	Migration and remittances central to rural livelihoods	Cross-sectional; no link to sectoral structure

Table 2.2 *Methodological comparison of literature strands*

Strand	Dominant data	Dominant method	Time coverage	National time-series econometrics?
Transformation theory/empirics	Cross-country panels	Decomposition, calibration	Long-run	Not for Uzbekistan
Transition agriculture	Farm surveys, cases	Comparative institutional	1990s-2000s	No
Uzbek agrarian studies	Ethnography, regions	Qualitative	Pre-2017 mostly	No
Policy literature	Official statistics	Descriptive	To ~2023	No

Three gaps emerge. There is a gap in coverage first by study; no study covers the entire period 1991-2025, and the post-2017 period of reform is an empirical under-researched period. Secondly a methodological gap: the Uzbek literature dealt with no formal time series analysis between structural composition (dynamics of shares of GDP) and agricultural employment and has overlooked the presence of nonstationary, cointegration and structural breaks, as pointed out by Granger and Newbold (1974) that can make naive level regressions spurious. Third, or an integration gap, theory-driven cross-country work is conducted independently from case studies, which are rich in the institutions in Uzbekistan, without a national level empirical check-up. This dissertation aims at all three aspects by estimating and critically interpreting the long-run and short-run relations between the composition of sectoral GDP (construction, service, manufacturing) and agricultural employment in Uzbekistan; with an explicit test for the structural breaks as predicted by the institutional literature for the period 1991-2025. This agenda is more formally established in Part 3.

METHODOLOGY

The research is guided by a positivist philosophy in that it is believed that there is an objective relationship between sectoral structure and agricultural employment which can be measured with observed data and tested with hypotheses (Saunders, Lewis and Thornhill, 2019). Nevertheless, following post-positivist developments, the study acknowledges the limitations of measurement - ILO employment statistics for the 1990s are modelled estimates - and thus does not make its findings definitive, but provisional and subject to probability, supplementing statistics with documentary evidence (Bryman, 2016).

3.2 Research design and strategy

A process of analysis adopted is quantitative-themed, deductive, and longitudinal analysis. A set of hypotheses based on structural transformation theory (Part 2) are tested using national time series data for the period 1991-2025. The research strategy is archival/secondary analysis, and the empirical core is an econometric analysis of official statistics to explain regime changes within the context of the official statistics used, namely; contextualization of regime changes through document analysis of policy reports and of legislation, and comparative analysis across the four policy sub-periods established in Part 1 (1991-1999 post-Soviet adjustment, 2000-2007 gradualist consolidation, 2008-2016 late-Karimov stagnation and 2017-2025 liberalization). Secondary analysis can be used when high-quality data are available and collecting original data is impractical and/or redundant (Johnston, 2014); replicability is also maximized.

3.3 Data collection and sources

The data provided with this dissertation includes 35 observations (1991-2025) for the three variables from World Bank Open Data: agricultural employment as a percentage of total employment (ILO modelled estimate) (World Bank, 2025a); industry (including construction) value added as a percentage of GDP (World Bank, 2025b); and services value added as a percentage of GDP (World Bank, 2025c). These indicators are generally used in the structural transformation literature (Herrdorf et al., 2014), internationally standardized and available over the whole period. Document analysis is based on documents from the World Bank, IMF, ADB and ILO that are authoritative and have coverage of the period of the reform. (Bowen 2009).

Table 3.1 *Variables and sources*

Variable	Definition	Role	Source
Y	Agricultural employment (% of total employment, ILO modelled estimate)	Dependent	World Bank (2025a)
X_1	Industry incl. construction, value added (% of GDP)	Independent	World Bank (2025b)
X_2	Services, value added (% of GDP)	Independent	World Bank (2025c)

3.4 Data analysis procedures

The analysis involves six steps, which are undertaken in Stata16. Descriptive analysis is used to describe measures of central tendency, dispersion and means of sub-periods and this is done with graphical inspection. Second, Pearson correlation and variance inflation factors (VIF) are measures of bivariate associations and multicollinearity. Thirdly, Augmented Dickey-Fuller (ADF) tests (Dickey and Fuller, 1979) confirm that each series is of the same order of integration, otherwise there will be spurious inferences in the regression of non-stationary series (Granger and Newbold, 1974). Fourth, the long run model

$$\mathbf{Y_t = \beta_0 + \beta_1 X_{1t} + \beta_2 X_{2t} + \varepsilon_t}$$

is estimated using OLS method. Standard errors are computed as Newey-West heteroscedasticity- and autocorrelation-consistent (Newey and West, 1987) and residual diagnostics such as Durbin-Watson, Breusch-Godfrey, Breusch-Pagan, Jarque-Bera are fully reported, as these series have been found to be serially correlated. Fifth, to test stationarity of long-run residuals, the Engle-Granger (1987) two-step procedure is followed; the first difference model without the ECT is estimated as a robustness check. Sixth, Chow (1960) tests for structural breaks in 2010 and 2017 which test for stability of the parameters in different policy settings, while sub-period trend

regressions estimate both the rate of shift in agricultural employment and the extent to which the rate of change accelerated after 2010.

3.5 Reliability, validity and ethics

Exclusive use of published international data, the complete scripted analysis pipeline for reliability. The major drawback is internal validity: the model's ability to detect associations, not identified causes, is not addressed through tests of statistical significance but in an interpretative manner, and this is explicitly stated in parts 5 and 6 (Wooldridge, 2013). Construction of validity is strengthened using indicator definitions that are common in the literature, and external validity is intentionally limited to the specific context of the study - Uzbekistan, with guarded and tempered comparison to other transition economies. Ethically, only information that may be seen as publicly available is used, with no human subject involved, with the only potential risk being that they will be accurately represented and that the sources will be credited appropriately, which is ensured using APA 7 referencing.

RESULTS AND ANALYSIS

Descriptive statistics are given in table 4.1 for the three series in the period 1991-2025. Meanwhile, agricultural employment is a different story entirely, with an average of 31.6 per cent of total employment and substantial variations from a peak of 39.5 per cent in 1994 to 25.2 per cent in 2025 a decline of roughly a third relative to the 1994 peak. Services has grown and increased its GDP share from 26.5 per cent to 46.5 per cent (the biggest structural shift in the dataset), and industry experienced a U-shaped trend, with its GDP share decreasing from 36.7 per cent in 1991 to around 20 per cent in the early 2000s before recovering to exceed 32 per cent by 2025. Even the negative excess kurtosis of the employment series (-1.60) is a result of the two high plateaus: one in the 1990s and another in the post-2010 period, as opposed to a smooth glide path.

Table 4.1 *Descriptive statistics, annual data 1991-2025 (N = 35)*

Statistic	Y: Agricultural employment (%)	X_1: Industry (% GDP)	X_2: Services (% GDP)
Mean	31.56	26.15	38.87
Median	28.93	24.57	38.75
Std. deviation	5.28	5.52	4.36
Minimum	25.20	13.34	26.54
Maximum	39.53	36.68	46.49
Skewness	0.41	0.10	-0.69
Excess kurtosis	-1.60	-0.61	0.99

Note. Author's calculations from the supplied dataset (World Bank, 2025a, 2025b, 2025c).

The three series are then graphed in the same way as in figure 4.1. There are three interesting things. First, whilst agriculture suffered industrial change and as in the previous transition recession, went deliberately into negative growth on employment, which barely occurred during the 1990s, increasing slightly to 1994, agriculture was the labor sink that employed workers from shrinking industry (X_1 decreased by 12 percentage points as of 1997). Second, Table 1.1 shows that the decline in agricultural employment between mid-1990s and the late 2000s holds substantially of the total decline, with most of this reduction from the mass restructuring of farming taking place during the 2000s-2010s period. Third, decreasing resumed following 2017, but on a noticeably shallower slope,

from a very low-level base. Over the entire period, there were a net decrease of 0.49 points per year (HAC $p < .001$, $R^2 = .90$), with a slight prevalence of a decrease of 0.63 points over time prior to the reform but 0.19 points afterwards, which is statistically significant and is further discussed below.

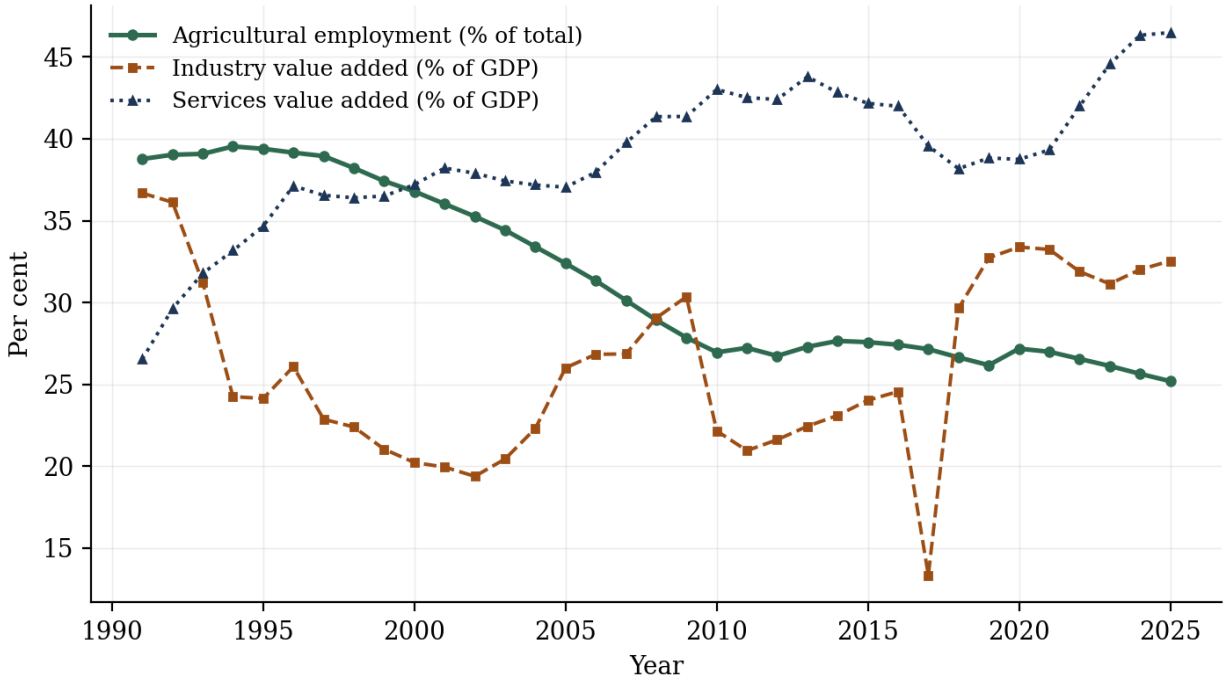

Figure 4.1. *Agricultural employment and sectoral GDP shares, Uzbekistan 1991-2025.*

One remark needs a special mention. The industrial series shows a sharp decrease in the 2017 figures to 13.3 per cent, followed by an increase to 29.7 per cent in 2018. The pattern is related to the unification of the exchange rate in September 2017 which resulted in a significant revision of the statistics and should thus be interpreted primarily as a measurement effect of the exchange rate unification process-a change that was not necessarily a downturn and recovery of industry activity. The inclusion of the observation in the output does not affect the significance or the signs of the other ones, and its inclusion in the final data set is a further factor that justifies, the rendering of the regression output together with the other information that help interpret data.

4.2 Correlation and multicollinearity

Pearson correlations are shown in Tab. 4.2. The negative correlation between agriculture employment and services share of GDP is high ($r = -.83$) while the negative correlation between industry share of GDP and agriculture employment is low ($r = -.14$). Weak industry correlation is a result of U-shaped trajectory of industry: During high employment of agriculture (early 90s) and low employment of agriculture (post-2018), there is a flat association of industry with agriculture. There is little relationship between either of these regressors and any other model variables (both regressors are highly correlated with nothing else; near zero correlation between the two regressors were observed: $r = -.15$; VIF = 1.02 for both). This is a nice reassurance because sectoral shares, in principle, can be mechanically related.

Table 4.2 *Pearson correlation matrix*

	Y	**X_1**	**X_2**
Y (Agricultural employment)	1.000		
X_1 (Industry)	-0.141	1.000	

	Y	X_1	X_2
X_2 (Services)	-0.826	-0.148	1.000

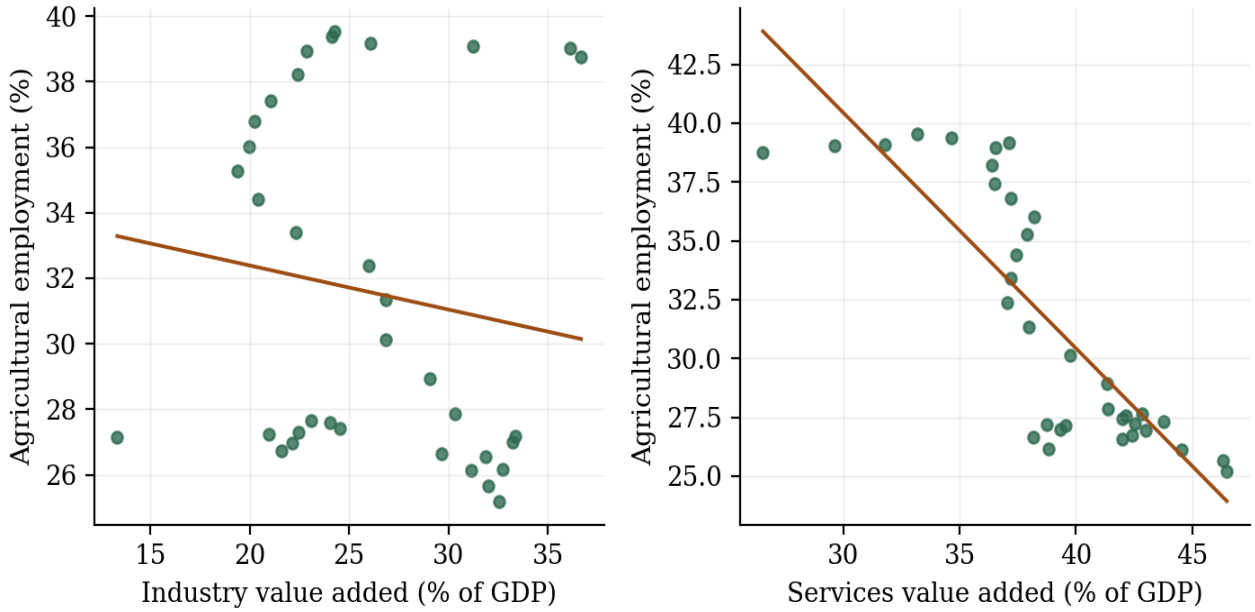

Figure 4.2. *Agricultural employment against industry and services GDP shares, with fitted lines.*

4.3 Unit-root tests

Due to the non-stationarity of macroeconomic level series, the tests were performed on levels and first differences (Table 4.3). All series (both Y and X_1 and X_2) remain not stationary at the 5 per cent level in levels, but are stationary in first differences, with all c.05-level p-values < .05. The three series are thus considered I (1). It has significant methodological consequences: if they are not cointegrated, the attractive fit of a level's regression is spurious in the Granger and Newbold (1974) sense of the word. The levels model along with the cointegration analysis are thus reported, and inference conducted with conscious care.

Table 4.3 *Augmented Dickey-Fuller tests (AIC lag selection)*

Series	Level: ADF stat	Level: p	First difference: ADF stat	First difference: p	Order
Y	-1.130	.703	-3.064	.029	I(1)
X_1	-2.714	.072	-6.451	<.001	I(1)
X_2	-2.546	.105	-2.919	.043	I(1)

4.4 Long-run regression estimates

The levels of regression standard errors computed using Newey-West HAC (three lags) are reported in Table 4.4. The model explains three-quarters of the variance in agricultural employment (R^2 = .752, adjusted R^2 = .737; F (2, 32) = 48.55, p < .001). Both the slope coefficients are negative and significant. For the association with the services share of GDP, a 1-percentage-point increase in the services share of GDP is linked to one decrease in the agricultural employment share of GDP (p < .001) while the association for industry is -0.26 points (p = .026). The equation estimated is:

$$\hat{Y} = 79.05 - 0.257 \cdot X_1 - 1.049 \cdot X_2$$

Table 4.4 *OLS estimates of the long-run model (dependent variable: Y)*

Regressor	Coefficient	HAC SE	t	p
Constant	79.048	7.254	10.90	<.001

Regressor	Coefficient	HAC SE	t	p
X_1 (Industry, % GDP)	-0.257	0.115	-2.23	.026
X_2 (Services, % GDP)	-1.049	0.131	-7.99	<.001

Note. N = 35. R^2 = .752; adjusted R^2 = .737; F = 48.55 (p < .001). Newey-West standard errors, 3 lags.

The diagnostic data (Table 4.5) is complex and cannot be presented without honesty. Residuals are normally distributed (Jarque-Bera p = .79) and homoscedastic (Breusch-Pagan p = .51); the Durbin-Watson statistic of 0.39 indicates strong positive autocorrelation - we can expect positive trends in annual data. Standard errors from HAC correct for this, but residuals from this system may be autocorrelated, suggesting a possible non-cointegrated relationship, which is studied next.

Table 4.5 *Residual diagnostics for the long-run model*

Test	Statistic	p	Conclusion
Durbin-Watson	0.387	-	Strong positive autocorrelation
Breusch-Godfrey (2 lags)	25.05	<.001	Serial correlation present
Breusch-Pagan	1.36	.508	No heteroscedasticity
Jarque-Bera	0.47	.791	Residuals normal
VIF (X_1, X_2)	1.02	-	No multicollinearity

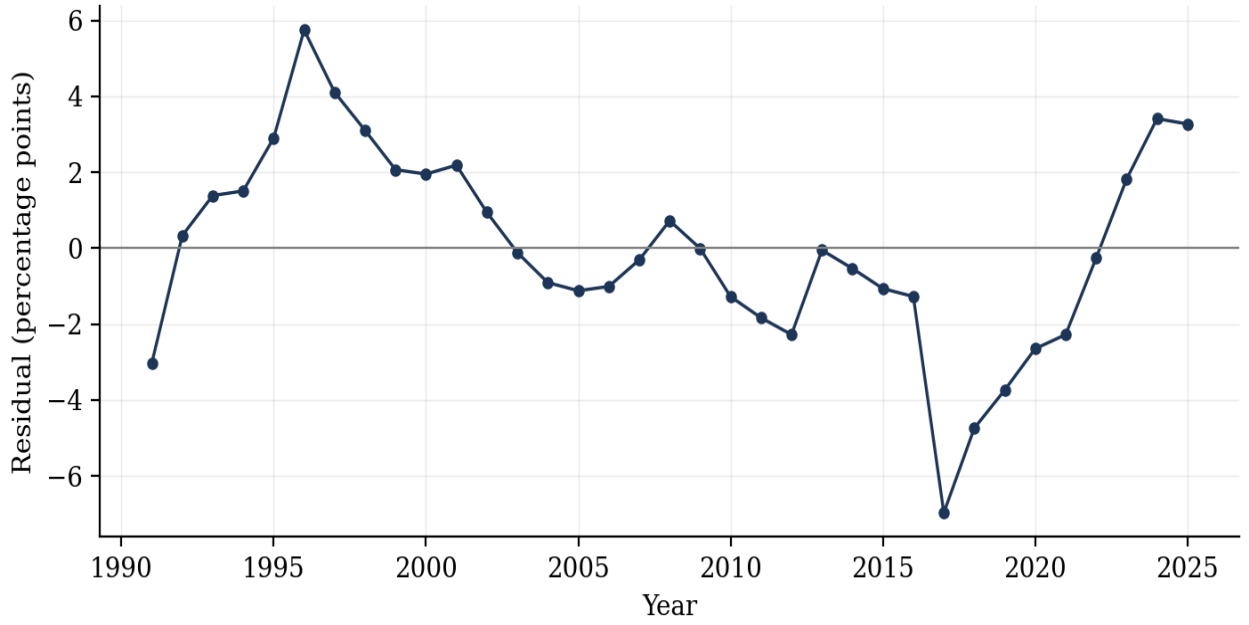

Figure 4.3. *Residuals of the long-run model, 1991-2025.*

4.5 Cointegration and error-correction dynamics

The Engle-Granger residual-based test fails to achieve rejection at usual levels of significance for the null of no cointegration (ADF on residuals = -1.85, p = .35). Reading Table 4.4 as a strong "long-run equilibrium" View makes this an admonishment against such a reading. Slow mean reversion characterized by persistent swings, however, appear in the residual plot (Figure 4.3); behavior that the Engle-Granger test has been known to miss in small samples. (See Engle and Granger (1987) and Wooldridge (2013) for details of the limitations of the Engle-Granger test in small samples.)

In addition, the significance of the error correction term also provides another test of

cointegration based on the ECM. The significance of the adjustment coefficient is more convincing evidence that the ECM is related over the long run and differs from the Engle-Granger procedure which relies on residuals; moreover, when size of the data sample is small, the significance of this adjustment coefficient is often more convincing (Kremers, Ericsson & Dolado, 1992; Banerjee et al., 1998).

There is complementary evidence from the error correction model (Table 4.6). The lagged error-correction term is negatively and significantly coefficients (-0.071 at p = .033) which suggests roughly 7 per cent of the mismatch between agricultural employment and its long-run equilibrium is corrected each year. At this rate, it takes approximately 9.4 years (half-life = ln (0.5)/ln (1-0.071)) to eliminate half of any given deviation - consistent with the slow adjustment implied by the weak Engle-Granger result above. In contrast, this provides further ground for believing that the residual test fell short of being conclusive. In the short run, only the change in the industry share has a (marginally) significant negative coefficient. (-0.039, p = .044); in the current period, services' share does not affect it (p = .92). The constant is noteworthy in that agricultural employment is decreasing by 0.41 percentage points annually, even if the sectoral employment proportions remain unchanged (p < .001). The same story is captured from a simple first difference model using both regressors as the variables, and the constant term is -0.40 (p = .002); none of the regressors are significant here, and the R^2 is .03.

Table 4.6 *Error-correction model (dependent variable: ΔY)*

Regressor	Coefficient	p
Constant	-0.407	<.001
ΔX_1	-0.039	.044
ΔX_2	-0.007	.921
ECT_{t-1}	-0.071	.033

Note. N = 34. R^2 = .126. HAC standard errors, 2 lags.

The main point and the main problem are the tight levels relationship - common long-run trends dominate any year-to-year relationship in agricultural employment while the structure (sectoral) relationship remains as a rather slow-moving anchor.

4.6 Structural breaks and sub-period dynamics

Chow tests decisively reject parameter constancy at both candidates break dates: 2010 (F = 24.39, p < .001) and 2017 (F = 16.15, p < .001). Sectoral structure and agricultural employment were therefore also inconsistent across policy regimes as illustrated in this institutional story, which is corroborated by the following relationship. The agricultural participation level trend regression, which narrows the picture, shows that compared to decreases of 0.63 points per year before 2017, the level of participation observed during 2017-2025 now shows a decrease of only 0.19 points per year (p = .016). Interestingly, the liberalization era, when services and industry grew at a good pace, is the least demanded one for agricultural jobs. This is argued in 6.3 as reflecting 2017 agricultural policy based on the elimination of mobilized labor (replaced by paid voluntary harvest labor) and on the toughening of labor shedding that had already occurred during the restructuring of farms in the 2000s.

4.7 Summary of results

Five findings move to the discussion. (2) Agricultural jobs decreased from ~39 to ~25 per cent of total jobs across 1991-2025, most significantly in the restructuring decade of the 2000s. Agricultural employment is strongly negatively correlated with the services share of GDP (β = -0.105, p < .001); it is also moderately negatively correlated with the industry share of GDP (β = -0.26; p =

.026) and the two regressors account for 75.2 per cent of the variation in agricultural employment (R^2 = .752) in the long run. The result indicates that all series I (1) and Engle-Granger tests now fail to detect cointegration, but a significant error-correction term (-0.071) will suggest slow adjustment to attain the structural association. (4) The sectoral change has small effect in the short-term and a steady decline (annual decline of -0.4 point) is more important. The relationship is structurally path- and policy-dependent and the exit of agricultural workers from the sector has been significantly diminished after 2017.

DISCUSSION

The overall finding, which depicts a strong negative long-run relationship between non-agricultural expansion and the share of farm employment in the economy, is qualitatively similar to the other most prevalent transformation rules of Kuznets (1973), Chenery and Syrquin (1975) and Herrendorf et al. (2014). But Uzbekistan's transition trajectory is instructive in that it is not the canonical one. When industries used agricultural labor, the structural pull was concentrated on agriculture and when services used agricultural labor the structural pull was concentrated on services; in the standard sequence, labor went from agriculture to industry first and was followed by labor from services, but in Uzbekistan the share of GDP of industry shrank, while the share of GDP of services grew, during the decade in which the total number of laborers was not increased in agriculture. This is reflected in an unequal coefficient of asymmetry (Table 5.4), which is lower for the transformation of industry (-0.26), than that for the transformation of services (-1.05). This is consistent with (overly) premature industrialization theory of Rodrik (2016), which found the industrial employment escalator largely closed, given that most of the growth in services in Uzbekistan has been in the trade, transport and construction-related services of low productivity (Ajwad et al., 2014; World Bank, 2022).

The change in the value of the coefficient has more theory than statistics behind it. The industrial coefficient was over 1 would have been expected had industrialization been the principal source of structural change, corresponding to the classic lewis-type shift of labor into industry. Rather, other patterns prevail. In contrast, the services share of employment with agriculture is about four times as high as for industry, suggesting that most of the services sector grew in the region at a much milder rate than the manufacturing sector experienced in earlier industrializers. This pattern supports Rodrik's (2016) hypothesis that some late-developing economies suffer from premature deindustrialization, in which manufacturing fails to be the usual prime mover upon the arrival of historically attended peak levels of employment. This has resulted in the shift of agricultural workers to service sector jobs rather than industrial jobs, thus creating a structural shift, which is not what East Asia or post-war Europe has experienced. This Uzbek evidence reinforces the point that there was potential for structural change within limited industrialization, but its productivity implications must be set against a lessened expectation than those generated by classic development literature.

During the transition recession, agriculture took up no more labor, but rather retained it, as the negative effect that Macours and Swinnen (2000) had observed, was overturned by Davis et al. (2010) who found that distress diversification happens in reverse. This contradicts a naive Lewis (1954) reading (i.e., the "modern" sector was shrinking, so intersectoral labor flows reversed) and furthers the notion that in transition economies the direction of intersectoral labor flows is regime-dependent and not monotonic. The fact that no single parameter vector fits the entire episode is formally confirmed by the major Chow breaks, which reveal that the entire episode is not covered by one parameter vector - as institutional literature (Spoor, 1995; Pomfret, 2006) suggests, and pooled cross-country studies hide.

5.2 Reconciling the levels and dynamics evidence

The results are taut as written: they fit the levels model perfectly, however there is no evidence of cointegration and short-run sectoral switching help to account for very little. There are three interpretations that can be given. The first is the 'spurious regression' reading (Granger and Newbold, 1974): three (and only three) time trending series of type I (1) will correlate strongly, even if there is no economic relationship, and the R^2 in regression of one from the other more than compensates the relation with structural content. Although there is a large error-correction term, this is partly because a purely spurious reading is opposed, but it is notable also that the coefficient of the term (-0.071) is small and the sample small, so that there are reasons for modesty. Walking the other side of the coin is the slow adjustment structuralism: adjusting size of the agricultural labor force in the long term, adjusting by factors due to frictions, with a nine-year half-life for rural housing and registration, farm labor requirements under the previous quota system, and a shortage of skills in the rural sector (Ajwad et al., 2014). This reading corresponds to the qualitative literature on the administrative labor retention in the cotton-dominated economy discussed (Kandiyoti 2003; Trevisani 2010): the institutions that failed to accelerate the reallocation of labor that the market would have done.

Here third interpretation comes into play, namely the drift term. That agricultural share has reduced as a result of labor-saving technical change in the cotton sector but also that a rise in the share of agriculture seems to have a net effect because of demographic entry of young people living in rural areas who remain non-agricultural reinforces the notion that agricultural job relocations are not entirely a product of this two-sector-shares dynamics, but that other factors - such as international migration - contribute as well. Seitz (2019) demonstrates that remittance-receiving households typically are rural and provides evidence that the workforce who are less needed in Uzbek agriculture but are more needed in Russian construction also lose their job from agriculture and do not increase employment-related GDP in domestic industry or services. The model coefficients for the short run are those that one might expect to obtain if a large proportion of the agricultural labor force is absorbed externally. It qualifies for the optimistic “Lewis’s style” use of Table 5.4, a part of Uzbekistan's measured transformation is the export, rather than allocational movement of, its surplus labor - the “migration reading” expected in Section 2.6.

5.3 The post-2017 puzzle

The most policy-relevant one might be the slowing nature of the exit of agricultural labor after 2017 (-0.19 points/year vs. -0.63 points/year), just at the time liberalization was anticipated to proceed. There are four mechanisms that are plausible and might all play a role. First, the reforms were intended to shift away from a mix of monoculture cotton and wheat (labelled labor-shedding) and towards more labor-intensive horticulture (World Bank, 2019); and second, the logic of factor bias suggests that such a shift doesn't lead to the loss of labor (Bustos et al., 2016). Second, remuneration: eradicating forced labor and boosting harvest rates introduced paid work to work previously unrecorded and without coexistence, making it more attractive (ILO, 2022), and likely to have reformat and enhanced the quality of agricultural jobs. Third, "base effects": the restructuring-induced 'shake out' of the early 2000s eliminated those most loosely attached to the agricultural sector, leaving only a core sector. Fourth, shocks: in 2020, migration corridors were closed and urban informal work shrank, temporarily reversing the downward trend (Y increased in 2020), highlighting the shock-absorber role of agriculture. An alternative explanation is that the slower post 2017 drop is a simple "base effect. However, by the 2010s farm restructuring-related labor surplus was largely eliminated by the farm reforms of the 2000s, so in this period the agricultural sector had a settled

workforce with lower mobility. This is a possible explanation and seems to be fragmentary. If the observed reduction was simply due to labor exhaustion, then the availability of agricultural labor should have continued to decrease in a steady manner as mechanization has progressed. Rather, reforms promoted diversification in horticulture at the same time as the cultivation of greenhouses by allowing a significant amount of labor inputs that demand a lot more labor seasonal than the mechanized cotton and wheat production. This interpretation follows that of Bustos et al. (2016) that the impact of agricultural modernization on labor requirements is related to the factor bias of agricultural modernization. The diversification dividend in Uzbekistan in the wake of 2017 seems to have been a reorientation of labor demand from more labor intensive industrial to more labor-intensive agricultural uses, rather than a mere mechanical reduction in labor withdrawal. The Chow-break in 2017 shows that this is not just a change of the guard, but a breaking down into a new regime. The conclusion, though, is that liberalization can stabilize agricultural employment while its relative contribution to GDP is diminishing, of course, does not necessarily collapse labor shedding and this is where the work by Rozelle and Swinnen (2004) on the liberalization-labor shedding link may need to be nuanced. Nevertheless, it does not follow that the implicit agriculture-related tax was removed by the same process of liberalization that drew labor out of agriculture, and this is where the linkage between liberalization and labor shedding put forward by Rozelle and Swinnen (2004) might need to be sharpened.

We should therefore keep in mind that the Pandemic episode is not signaling a new long-run trend but rather an interruption to it. Restrictions on international labor mobility significantly curbed the availability of labor mobility opportunities, while the decline of the informal sector in cities promoted some workers to either stay in or to temporarily return to the agricultural arena. Gradually reopening migration channels and fill-up of urban demand for labor led to a slight resumption of a downward trend in employment in farming. The combination of these sequences indicates that the apparent rise in 2020 was due to some response to changes in the labor market, instead of a realization of transformation. On a broader level, the episode underscores the continued need to maintain the agriculture sector as a buffer sector in times of economic volatility as agricultural employment was apparently stabilized after the 2017 period, despite continued vulnerability to shocks in migration, market demand for agricultural labor and livelihood approaches.

5.4 Regional perspective and sustainable development

When taking into account regional differences, Uzbekistan's path falls somewhere between consolidated Kazakhstan and smallholder-dominated Kyrgyzstan in terms of the speed of agricultural labor exit and when it occurred-marking a path that is both more rapid than in Kyrgyzstan and more gradual than in consolidated Kazakhstan, while also broadly supporting the endowment-conditioned reform paths outlined by Swinnen and Rozelle (2006) and Lerman (2009) that indicate that farm structure shapes employment outcomes. The results also relate to the Sustainable Development Goals. The shift towards a stable agricultural employment level since 2017, at the same time as forced labor had been eradicated (according to ILO (2022), constitutes an unambiguous measure on the decent-work aspect of SDG 8. A similar level of agricultural employment correlates to better paid, voluntarily provided work. The progress towards SDG 1 and SDG 2 is less unequivocal. Household incomes increase if a proportion of (rural) labor leave for employment overseas, as remittances do (Seitz 2019), but so long as such migration continues to respond to shocks - as the COVID-19-induced decrease and resurgence of agricultural employment this year in 2020 proves - household income continues to be vulnerable. The condition of an inclusive transformation in the sense of the United Nations (2015)

- such that the domestic economy, rather than foreign labor markets, should be the primary end market for those leaving farming - is arguably not present, as weak short-run coefficients were estimated here.

The findings will also have a wider impact on Sustainable Development Goals (SDG), beyond SDG 8. Reducing the number of people in agriculture is essential for progress towards SDG 1 (No Poverty) and SDG 2 (Zero Hunger) but working on improved productivity and resilience of rural livelihoods is equally important. In contexts where the incomes of most households are more driven by remittances, not necessarily by productivity growth in their home agricultural production, measured poverty alleviation in rural areas may fail to reveal underlying shortcomings. While migration is significant as a coping mechanism and an income-generating option, it cannot fully replace and compensate for any compensation for long-term improvement in agricultural productivity, value addition, and rural employment opportunities. Thus, the structural transformation must go together with investment in agricultural productivity and not labor export to move towards SDG 1 and SDG 2 in the long term.

Initial factor endowments and institutional factors are also significant as shown by a comparison with neighboring Central Asian countries. The labor changes in agriculture were much quicker in Kazakhstan, owing to the capital-intensive production and relative affluence of its agricultural land resources, while as early household agricultural land was distributed in Kyrgyzstan, facilitating smallholder agriculture and postponing the large-scale displacement of labor. While agrarian reform was also slower in Tajikistan than in Uzbekistan, remittances emerged as a key aspect of rural livelihoods due to exceptionally high labor mobility in this country. The different porousness leads to different labor outcomes of these contrasting reforms, which bolster the comparisons presented by Swinnen and Rozelle (2006) and Lerman (2009) that similar reform goals can result in vastly different labor outcomes depending on irrigation dependence, land availability and institutional arrangements. Its transformation path is different from that of its neighbors because of the density of its rural population, the fact that agriculture is irrigated and that there has been a long period of state intervention.

5.5 Contribution, implications and limitations

The study is original relative to the research gap of Part 2 in the sense that it elaborates the first-ever national time-series analysis for the entire period to date on link between the sectoral structure of the economy of Uzbekistan and the employment in agriculture, taking into consideration the non-stationarity of variables and the presence of structural breaks, and brings together the econometric analysis with the institutional literature without keeping them parallel. There are three implications for policy. First, entering into the service sector does not automatically lead to increased productivity content of an exit; there is a need to complement this with active complements such as rural skills programmes, transport links and support for agro-processing, which can facilitate the linkage between farm and industry to increase the productivity content of exits (Sadoulet and de Janvry, 2010; Christiaensen et al, 2011). Second, there is the labor-retaining aspect to horticultural diversifications which can be viewed as a policy of benefit to the management of the large rural youth population, and which should not be overlooked in concentrating on efficiency gains from pure mechanization. Third, the migration channel reduces even further the overall reported shift in the huge allocation of the Uzbek labor force in agriculture; emigration should be regarded as a part of the structural change in the labor force allocation, rather than the externality of it.

Another constraint is that of the discontinuity measurement during the reform period 2017.

The sudden shift in industry's GDP share of the economy (as summarized in Part 5) did not signal a sudden plunge and quick recovery in industrial output, rather it was linked to exchange rate liberalization and statistical revisions. The episode shows that the treatment of this observation has no impact on the direction or statistical significance of the main coefficients, and therefore robustness checks suggest that a decision to retain this observation does not afflict any of the other results. However, it does demonstrate how institutional changes can affect economic reality as well as the statistical model in which it is measured. Therefore, the reported coefficients ought not to be seen as strictly mechanical ties, but rather connections built amidst a fluctuating measure environment. This emphasizes the main methodological point that has been discussed throughout the dissertation, namely that econometric results need always to be read in the light of institutional evidence, in the case of transition economies during essential policy reform.

Limits are “material” and are explicitly declared. It is a model with two regressors and 35 observations. Omitted variables (wages, mechanization, remittances, weather, demography) imply that the coefficients are associations rather than causal effects. The outcome variable is dependent variable; values for the outcome variable measured in the 1990s incorporate assumptions; measurement errors are likely non-classical at the regime changes (forced labor abolition). The Engle-Granger procedure is not very powerful in small samples, and the Chow tests assume of known break timing points, rather than the assumption of the break breaks being endogenous (Bai-Perron). Finally, it’s not easy to generalize from a single country’s design.

CONCLUSION AND RECOMMENDATIONS

The aim of this dissertation was to find out to what extent the agricultural employment of Uzbekistan has related to the structural economic change during 1991-2025. The descriptive analysis identified that the share of agriculture jobs dropped from 39 to 25 per cent, with the farm restructuring decade being the period of greatest employment loss, while the share of services increased by 20 percentage points and the number of jobs in the service sector grew in a U-shape form, with the employment loss in the services sector occurring in the 2010s. All series were detected as I (1) in terms of the long-run model, with the agricultural share showing a strong and negative association with the services share of GDP ($\beta = -1.05$, $p < .001$), and the industry share was more weakly associated with agriculture ($\beta = -0.26$, $p = .026$), accounting for 75 per cent of the variance, though with the explicit proviso that cointegration remains unconfirmed on this small set of samples. For objective 3, error correction model showed that the process of error correction was significant but rather slow ($\gamma = -0.071$) and that the autonomous drift was very distinct (-0.4 points per year), suggesting that sectoral change in any one year is more likely to have date-related, rather than contemporaneously sectoral, origins. Against Objective 4, the Chow test rejected parameter stability in 2010 and 2017, and the exit rate of agricultural labor decreased by two-third in the liberalization period. These results were interpreted as a structural change (tertiarization) but one in which some economic activities were partly externalized and in which any dual-economy dynamic account is not possible in the theory of frictionless dual-economy; consistent at the same time with the broad regularities of the long run that are called “Kuznets-Chenery” regularities.

The overall answer to the research question, then, is provisional. The farm share of GDP is a binding long-term feature of Structural change and agricultural employment; structural change dynamics is now bound to agriculture and agricultural employment by the slow nature of the response, dependence on country regimes, and institutions (state orders, forced labor, land restrictions), as well as by an international migration channel that is not observed in the national accounts.

6.2 Recommendations for policy

Three recommendations follow. First, the government's diversification program must be complemented, on the one hand, by a vision of rural transition (vocational retraining) and, on the other hand, by rural connectivity and agro-processing clusters, as the evidence indicates a slow reallocation of agricultural labor (around 10 years) in conformance with sectoral growth. Second, promoting labor-using modernization in the agricultural sector (horticulture, livestock, food processing) remains central to modernization over indiscriminate mechanization and a large section of the youth must stay in the labor market, as this balance has worked to maintain stability in the employment market after 2017. Third, statistical agencies should combine migration and remittance information to provide labor-market monitoring systems with information on the welfare consequences of declines in rural employmentership, which are either to allocate employment to better returns or to have labor exported, a crucial element to gauge advances towards SDG 8.

6.3 Recommendations for future research

Based on the ARDL bounds-testing approach proposed by Pesaran, Shin and Smith (2001), the robustness of the long run analysis can be enhanced in future studies. The ARDL procedure being proposed in contrast to the Engle-Granger procedure, not assuming all variables are of same order of integration is more appropriate for small samples and it is more suitable to be used in the studies with annual macroeconomic data for Uzbekistan.

6.4 Limitations of the study

The conclusions in the above section must be regarded with the following limitations: Second, there are only thirty-five observations in the annual data (1991-2025); Engle-Granger residual-based tests are known to be weak in small samples, so it is unlikely they would have been more powerful in this case and thus rejected the null of no cointegration when they actually did not. This would also be partially achieved by the ARDL bounds-testing approach, but the sample-size issue would remain, as the analysis would still depend on the same thirty-five annual data points, and both higher-frequency data and a longer data history are lacking in the post-independence history of Uzbekistan.

Second, both structural regressors are simply shares of aggregate value added and do not represent direct measures of Technology change, or of capital intensity or productivity change across the sectors. Industry and services GDP shares are very good proxies for structural change and are internationally comparable, but they capture several underlying processes rather than one, namely: capital deepening, price effects, terms of trade movements and actual reallocation of value added which are not separated in one-shot. In regard to GDP-share data, an unusual observation in the industry made in 2017 is especially noteworthy: this observation was based on the unification of exchange rates rather than any actual shifts in industry output, and the validity of this observation should be applied to the pre-2017 series, for which the economies measured a different valuation and statistical regime.

Thirdly, the ILO estimate of agricultural employment share is not measured in the same way as a labor force survey for the period as a whole-it is actually a modelled estimate, which fills in the missing years in the nationally collected data series and can have somewhat low short-run volatility, especially in the years of the farm restructuring-induced institutional transition that occurred in the 2000s period. This may account for the fact that only a small proportion of variation in output in the short run is captured by the error-correction model (shows $R^2 = .126$). Much of the "noise" in the model might simply be the result of smoothing in its measurement, and not a real lack of short-run dynamics.

Fourth, the study cannot observe international labor migration per se, yet this is again a theme in the discussion (Part 5) that parts of the labor freed up from agriculture are externalized via migration routes. The national accounts and employment statistics of Uzbekistan sometimes do not distinguish between reallocation in the domestic sector from labor that has left the country due to migration or remittance-induced non-participation. The change in the agricultural sector's share of employment that cannot immediately be accounted for within domestic industry and services is therefore indirectly included as migration "residual" and the size of this channel could only be measured with matched migration and household-survey data that was not available for this study.

Fifth, unlike other endogenous break-detection methods, like the Bai-Perron test, break dates are selected based on known policy events (the end of the farm restructuring decade, and in 2017 liberalization reforms). It is probably a defensible decision in light of the institutional context of the study; however, it is important to note that the Chow tests validate instability within the selected, theory-driven years and do not determine the "best" year to join the series; in principle, there could be a different year of instability within the series that would support the causal hypothesis if it occurred on the same calendar year of policy changes.

Lastly, the analysis only characterizes the experience of one country over one transition over time, and the estimated coefficients here reflect performance for the state of Uzbekistan; they do not capture or suggest a more broadly credible elasticity of agricultural employment on transition itself. Certainly, it should not be assumed for other economies in Central Asia, or in the former Soviet Union, that the relationship between elasticities and the 7 per cent annual adjustment rate can be extended beyond the economies considered here without re-estimating the relationship from their data.

REFERENCES

1. Ajwad, M. I., Abdulloev, I., Audy, R., Hut, S., de Laat, J., Kheyfets, I., Larrison, J., Nikoloski, Z., & Torracchi, F. (2014). *The skills road: Skills for employability in Uzbekistan*. World Bank. https://documents1.worldbank.org/curated/en/744581468230693258/pdf/910100WP0P14350d000Uzbekistan0Final.pdfdocuments1.worldbank
2. Abdusattarov, B., Safarov, A., & Toshmatov, B. (2023, April). Determination of the influence of packaging measures of a variety of Husayni grapes. In *E3S Web of Conferences* (Vol. 381, p. 01006). EDP Sciences.
3. Asamov, R. B. (2025a). Digital transformation and the impact of modern technologies on agricultural management in Uzbekistan. *Green Economy and Development, 3*(2), 13-18. https://doi.org/10.5281/zenodo.15017273
4. Asamov, R. B. (2025b). Innovative management systems in agriculture and their role in global integration. *International Scientific and Practical Conference: Integration of Innovation and Investment Processes in Science and Education, Production and Economy*. https://doi.org/10.5281/zenodo.15332012
5. Avazov, S., & Lee, S. (2022). E-government services adoption in Uzbekistan: An empirical validation of extended version of the Unified Model of Electronic Government Acceptance (UMEGA). Journal of Policy Studies, 37(3), 15-37. https://doi.org/10.52372/jps37302
6. Azizov, A. S., & Abdusattorov, B. A. (2020). Qualitative Organizing of Storage Process of Table Grape Varieties by Using Grape Guard Sheets in Cold Storage Scopus. *International Journal of Advanced Science and Technology Australia*, *29*(11s), 1943-1948.

7. Alvarez-Cuadrado, F., & Poschke, M. (2011). Structural change out of agriculture: Labor push versus labor pull. *American Economic Journal: Macroeconomics, 3*(3), 127-158. https://www.aeaweb.org/articles?id=10.1257/mac.3.3.127aeaweb
8. Bustos, P., Caprettini, B., & Ponticelli, J. (2016). Agricultural productivity and structural transformation: Evidence from Brazil. *American Economic Review, 106*(6), 1320-1365.
9. Christiaensen, L., Demery, L., & Kuhl, J. (2011). The (evolving) role of agriculture in poverty reduction: An empirical perspective. *Journal of Development Economics, 96*(2), 239-254.
10. Davis, B., Winters, P., & Carletto, G. (2010). A cross-country comparison of rural income generating activities. *World Development, 38*(1), 48-63. https://www.sciencedirect.com/science/article/pii/S0305750X09000163sciencedirect
11. Djanibekov, N., van Assche, K., Bobojonov, I., & Lamers, J. P. A. (2012). Farm restructuring and land consolidation in Uzbekistan: New farms with old barriers. *Europe-Asia Studies, 64*(6), 1101-1126.
12. Duarte, M., & Restuccia, D. (2010). The role of the structural transformation in aggregate productivity. *Quarterly Journal of Economics, 125*(1), 129-173.
13. Food and Agriculture Organization. (2017). *The state of food and agriculture 2017: Leveraging food systems for inclusive rural transformation*. FAO.
14. Gollin, D., Lagakos, D., & Waugh, M. E. (2014). The agricultural productivity gap. *The Quarterly Journal of Economics, 129*(2), 939-993. https://academic.oup.com/qje/article-abstract/129/2/939/1866319?redirectedFrom=fulltextacademic.oup
15. Guadagni, M., Raiser, M., Crole-Rees, A., & Khidirov, D. (2005). *Cotton taxation in Uzbekistan: Opportunities for reform* (ECSSD Working Paper No. 41). World Bank.
16. Herrendorf, B., Rogerson, R., & Valentinyi, Á. (2014). Growth and structural transformation. In P. Aghion & S. N. Durlauf (Eds.), *Handbook of economic growth* (Vol. 2, pp. 855-941). Elsevier.
17. International Labor Organization. (2022). *2021 third-party monitoring of child labor and forced labor during the cotton harvest in Uzbekistan*. ILO.
18. Johnston, M. P. (2014). Secondary data analysis: A method of which the time has come. *Qualitative and Quantitative Methods in Libraries, 3*(3), 619-626.
19. Lerman, Z. (2008). Agricultural development in Central Asia: A survey of Uzbekistan, 2007-2008. *Eurasian Geography and Economics, 49*(4), 481-505. https://doi.org/10.2747/1539-7216.49.4.481tandfonline
20. Lerman, Z. (2009). Land reform, farm structure, and agricultural performance in CIS countries. *China Economic Review, 20*(2), 316-326. https://www.sciencedirect.com/science/article/abs/pii/S1043951X08000771sciencedirect
21. McMillan, M., & Rodrik, D. (2011). Globalization, structural change and productivity growth (NBER Working Paper No. 17143). National Bureau of Economic Research. https://www.nber.org/system/files/working_papers/w17143/w17143.pdfnber
22. Ngai, L. R., & Pissarides, C. A. (2007). Structural change in a multisector model of growth. *American Economic Review, 97*(1), 429-443.
23. Pomfret, R. (2019). *The Central Asian economies in the twenty-first century: Paving a new Silk Road*. Princeton University Press.
24. Primov, A. Crop Diversification Analysis at the Farm Level: Empirical Evidence from Different Regions of Uzbekistan. ZBW - Leibniz Information Centre for Economics: Kiel/Hamburg, Germany, 2025. Available online: https://hdl.handle.net/10419/313532.

25. Primov, A.; Kuhn, L.; Bobojonov, I.; Glauben, T. Crop diversification and its effect on farm income: Evidence from a farm survey in Uzbekistan. *Journal of Social and Economic Development* 2025. https://doi.org/10.1007/s40847-025-00488-z
26. Ruziev, K., Ghosh, D., & Dow, S. C. (2007). The Uzbek puzzle revisited: An analysis of economic performance in Uzbekistan since 1991. *Central Asian Survey, 26*(1), 7-30.
27. Seitz, W. (2019). International migration and household well-being: Evidence from Uzbekistan (Policy Research Working Paper No. 8910). World Bank.
28. Trevisani, T. (2010). Land and power in Khorezm: Farmers, communities and the state in Uzbekistan's decollectivisation. LIT Verlag.
29. United Nations. (2015). Transforming our world: The 2030 Agenda for Sustainable Development (A/RES/70/1). United Nations General Assembly.
30. Veldwisch, G. J., & Spoor, M. (2008). Contesting rural resources: Emerging 'forms' of agrarian production in Uzbekistan. Journal of Peasant Studies, 35(3), 424-451.
31. Wooldridge, J. M. (2013). Introductory econometrics: A modern approach (5th ed.). South-Western Cengage Learning.
32. World Bank. (2022). Toward a prosperous and inclusive future: The second systematic country diagnostic for Uzbekistan. World Bank.
33. World Bank. (2025a). Employment in agriculture (% of total employment) (modeled ILO estimate) - Uzbekistan [Data set]. World Bank Open Data. https://data.worldbank.org/indicator/SL.AGR.EMPL.ZS?locations=UZ
34. World Bank. (2025b). Industry (including construction), value added (% of GDP) - Uzbekistan [Data set]. World Bank Open Data. https://data.worldbank.org/indicator/NV.IND.TOTL.ZS?locations=UZ
35. World Bank. (2025c). Services, value added (% of GDP) - Uzbekistan [Data set]. World Bank Open Data. https://data.worldbank.org/indicator/NV.SRV.TOTL.ZS?locations=UZ

Appendices

Appendix A: Dataset

Table A1 *Annual data used in the analysis, 1991-2025*

Year	Y: Agricultural employment (%)	X_1: Industry (% GDP)	X_2: Services (% GDP)
1991	38.77	36.68	26.54
1992	39.03	36.13	29.63
1993	39.08	31.23	31.78
1994	39.53	24.25	33.17
1995	39.39	24.14	34.66
1996	39.16	26.08	37.12
1997	38.95	22.87	36.55
1998	38.22	22.40	36.40
1999	37.42	21.05	36.50
2000	36.79	20.23	37.19
2001	36.02	19.95	38.21
2002	35.26	19.39	37.90
2003	34.42	20.45	37.43

Year	Y: Agricultural employment (%)	X_1: Industry (% GDP)	X_2: Services (% GDP)
2004	33.41	22.31	37.18
2005	32.39	26.01	37.04
2006	31.33	26.84	37.96
2007	30.14	26.86	39.76
2008	28.93	29.07	41.35
2009	27.86	30.35	41.37
2010	26.96	22.16	43.01
2011	27.23	20.96	42.52
2012	26.74	21.62	42.40
2013	27.30	22.45	43.79
2014	27.66	23.11	42.83
2015	27.58	24.03	42.17
2016	27.42	24.57	41.99
2017	27.15	13.34	39.56
2018	26.65	29.65	38.18
2019	26.18	32.74	38.83
2020	27.19	33.39	38.75
2021	26.99	33.24	39.32
2022	26.56	31.89	41.98
2023	26.13	31.14	44.56
2024	25.65	32.01	46.33
2025	25.20	32.54	46.49

Note. Source: World Bank (2025a, 2025b, 2025c). The 2017 industry value reflects the statistical revision accompanying exchange-rate unification.

Appendix B. Variable Definitions and Data Sources

Table B1. Description of variables used in the analysis

Variable	Indicator	Unit	Source	Purpose
Agricultural Employment	Employment in agriculture (% of total employment)	%	World Bank Open Data (ILO modelled estimate)	Dependent variable
Industry	Industry (including construction), value added (% of GDP)	% of GDP	World Bank Open Data	Independent variable
Services	Services, value added (% of GDP)	% of GDP	World Bank Open Data	Independent variable

Notes

i. Annual observations cover the period 1991-2025 (N = 35).
ii. All indicators were downloaded from the World Bank Open Data database.
iii. Agricultural employment is based on ILO modelled estimates to ensure consistency over time.
iv. No missing observations were present in the dataset.
v. No interpolation or imputation was required.

Appendix C. Summary of Research Hypotheses

Table C1. Summary of statistical hypothesis

Hypothesis	Statement	Statistical method	Result
H1	Growth of the industry share is associated with lower agricultural employment.	OLS regression	Supported
H2	Growth of the services sector is negatively associated with agricultural employment.	OLS regression	Supported
H3	The variables exhibit non-stationarity.	ADF test	Supported
H4	Agricultural employment adjusts towards long-run equilibrium.	ECM	Partially supported
H5	Structural relationships changed after the major reforms.	Chow test	Supported

Appendix E. Additional Methodological Notes

This appendix contains additional methodological details to complement the empirical analysis that is presented in Parts 4 and 5. These were not mandatory to put in the central part of the dissertation, but they make the research process more transparent and replicable. All analysis was restricted to secondary data publicly available from secondary sources which were internationally recognized and all the statistical procedures took place according to the standard norm in the field of econometric methods adopted by agricultural and development economics practitioners. The risk of undesirable bias of inference due to autocorrelation, heteroskedasticity and stationarity was minimized by using robust estimation techniques and diagnostic tests. The results observed in this dissertation therefore can be repeated if an identical data set and statistics are used.