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Intergenerational Labor Market Transitions in MENA:

Exploring the Impact of Climate Shocks

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Abstract

This paper examines how climate shocks influence intergenerational labor market transitions in the Middle East and North Africa (MENA), with a focus on Egypt. Using panel data from the Egypt Labor Market Panel Survey (1998–2023) combined with district-level temperature anomalies from NASA POWER, we investigate the extent to which climate shock disrupt the occupational trajectories between fathers and sons, particularly transitions in and out of agricultural employment. Employing a Difference-in-Differences event-study framework with two-way fixed effects, we estimate the dynamic impact of climate anomalies on intergenerational mobility elasticities. Preliminary findings indicate that heat shocks reduce persistence in agricultural occupations across generations and modestly weaken intergenerational occupational mobility ($p \approx 0.08$), especially in Upper Egypt governorates. These effects suggest that climate shocks may exacerbate structural labor market rigidities and deepen intergenerational inequality. Policy implications include the need for climate-adaptive labor policies, targeted educational investments, and resilience-building measures for vulnerable households. The study contributes novel evidence on the long-term repercussions of climate change on intergenerational labor dynamics in developing country settings, highlighting the urgency of integrating climate resilience into labor market strategies in the MENA region.

Keyword: Labor market transitions; Climate shocks; Occupational persistence; Agriculture; Difference-in-Differences (DiD); Event-study; MENA region; Egypt.

JEL classification codes: J62, Q54, C23, O55

1. Introduction

The intensifying pace of climate change has become one of the most transformative forces shaping global development trajectories, influencing not only environmental systems but also economic performance, social welfare, and labor markets. For countries in the Middle East and North Africa (MENA), particularly Egypt, the intersection of environmental vulnerability and socioeconomic fragility has heightened concerns about the long-term sustainability of livelihoods. Increasingly frequent heatwaves, erratic precipitation, and persistent water scarcity are already reshaping patterns of employment and productivity (El Raey et al., 2015; Trisos et al., 2022; Abou-Ali et al. 2023).

Over the past four decades, Egypt has experienced one of the fastest warming rates in the Middle East and North Africa. National and reanalysis climate records show that average annual temperatures have increased by 0.36–0.41°C per decade since the 1980s, nearly double the global rate of warming (IPCC, 2022; World Bank Climate Change Knowledge Portal, 2023). According to NASA POWER and ERA5 datasets, mean summer temperatures are now approximately 1.2°C warmer than the 1991–2010 baseline, with Upper Egypt governorates such as Aswan, Luxor, Qena, and Sohag regularly recording summer maxima exceeding 44–46°C (NASA POWER, 2024; Hersbach et al., 2020). The number of "extremely hot days" (>40°C) has more than doubled since 1990, rising from about 8 days per year to over 20 days per year nationally, and surpassing 45–60 days annually in parts of Upper Egypt (WMO, 2023; Zittis et al., 2021). Projections from the IPCC indicate that Egypt is likely to exceed the 1.5°C global warming threshold by the mid-2030s, even under moderate emissions scenarios, and could experience an additional 2.0–2.5°C of warming by mid-century (IPCC, 2021; IPCC, 2022). Such increases are expected to raise the frequency of extreme heat events by up to fourfold, with wet-bulb temperatures approaching levels that pose substantial risks for outdoor agricultural labor (Raymond et al., 2020; IPCC, 2022). These empirical trends underscore the growing importance of climate shocks in shaping household livelihoods and intergenerational occupational trajectories. Rising temperatures and intensifying droughts are undermining productivity, disrupting crop cycles, and limiting labor capacity through heat-related health effects (Abd El-Mohsen et al., 2021).

In Egypt, these climatic pressures converge with structural labor market challenges—such as high youth unemployment, persistent informality, and strong intergenerational linkages in occupation—to produce a complex dynamic of environmental and socioeconomic risks. Agriculture continues to serve as a critical source of employment and household income, particularly for rural families, with roughly 45 percent of fathers and sons engaged in agricultural work. Figure 1 illustrates the evolution of agricultural employment among fathers and sons across the five ELMPS survey rounds (1998, 2006, 2012, 2018, 2023). Fathers remain much more concentrated in agriculture than sons throughout all survey years.

The red dashed line shows that 44–49% of fathers were employed in agriculture between 1998 and 2012—a period during which the agricultural sector still dominated rural livelihoods. Although this share begins to decline after 2012, it remains high relative to sons, falling only to about 34% by 2023. Sons show consistently lower participation in agriculture, with a mild rise in the 2000s followed by a steady

decline after 2012.
The blue line indicates that sons' agricultural participation fluctuates between 17% and 21%. Notably, their participation rises modestly between 1998 and 2006, stabilizes around 2012, and then declines steadily to roughly 16% by 2023. This downward trend highlights a generational shift away from agriculture toward non-farm and informal urban work. The post-2012 decline aligns closely with intensifying climate stress in Egypt.
Around 2010–2012, Egypt experienced a marked increase in extreme heat anomalies and prolonged summer heatwaves, particularly in Upper Egypt. This period corresponds to the beginning of the sharp drop in agricultural employment for both generations. The pattern is consistent with the emerging literature showing that rising temperatures reduce agricultural productivity, increase labor fatigue, and encourage younger workers to exit climate-exposed sectors. The widening gap between generations signals weakening intergenerational persistence in agriculture.
While the father–son gap is persistent across all years, it widens notably after 2012, suggesting that sons are increasingly unwilling—or unable—to remain in agriculture under worsening climate and economic conditions. This supports your empirical finding that heat shocks reduce intergenerational occupational persistence.

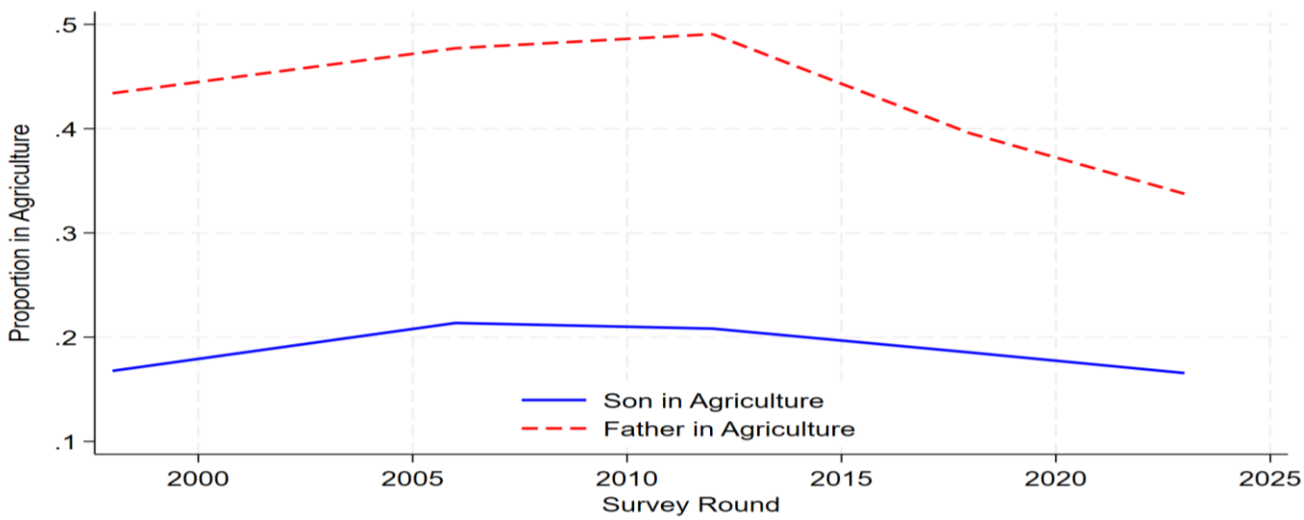

Figure 1: Trend in Agriculture Participation over ELMPS rounds
Source: Authors' calculations from ELMPS.

Despite the growing recognition that climate shocks influence labor outcomes, the intergenerational transmission mechanisms through which environmental stressors affect occupational mobility remain underexplored. In other words, while much is known about how weather shocks impact current employment or wages, far less attention has been paid to how these disruptions shape the ability of children to move beyond their parents' occupations. This question is crucial for understanding how climate change may entrench existing inequalities or hinder upward mobility across generations.

This paper investigates how climate shocks—maximum temperature anomalies—affect intergenerational labor market transitions in Egypt, emphasizing the agricultural sector. Using a combination of longitudinal microdata from the Egypt Labor Market Panel Survey (ELMPS, 1998–2023) and climate indicator from NASA POWER, the study estimates the causal effects of climate variability on occupational persistence and transitions between agriculture and non-agriculture. The analysis employs a difference-in-differences (DiD) and event-study framework to capture dynamic effects and heterogeneity across regions and population subgroups.

The study contributes to literature in three major ways. First, it introduces an intergenerational perspective to the climate–labor nexus, demonstrating how environmental stress can influence not just individual labor outcomes but also family-level occupational inheritance. Second, it extends empirical identification techniques by incorporating staggered treatment timing and high-resolution climate variation, building on recent econometric developments in causal inference (Callaway & Sant'Anna, 2021; Sun & Abraham, 2021). Third, it offers policy-relevant evidence for Egypt and other MENA economies on how climate adaptation and social protection strategies can mitigate the long-term distributional effects of environmental shocks.

The remainder of this paper is structured as follows. Section 2 reviews relevant literature on labor market mobility and climate–labor linkages in the MENA context. Section 3 outlines the conceptual framework explaining the pathways through which climate shocks affect intergenerational occupational outcomes. Section 4 describes the datasets and variable construction. Section 5 presents the empirical methodology, followed by Section 6 discussing the results. The final sections provide policy implications and concluding remarks.

2. Literature Review

2.1 Intergenerational Labor Market Mobility in MENA

Research on intergenerational mobility in the MENA region consistently finds that social and economic status is strongly inherited, particularly in Egypt (Assaad & Salehi-Isfahani, 2019; Salehi-Isfahani, 2017). Family background—manifested through parental education, occupation, and social networks—remains one of the strongest predictors of an individual's labor market outcomes. This persistence has been attributed to rigid institutional structures, segmentation between public and private sectors, and limited access to quality education.

In Egypt, occupational inheritance is especially prominent in agriculture, where approximately 45 percent of sons work in the same sector as their fathers. Upward mobility—typically reflected by a transition from agricultural to non-agricultural work—has been slow and uneven across regions. Assaad (2011) describes Egypt's labor market as bifurcated between a protected public sector, which provides stability but limited entry, and a large informal private sector, characterized by low wages, precarious conditions, and minimal social protection. As a result, many workers remain trapped in low-productivity activities, unable to transition to more secure employment.

Gender dynamics further constrain labor mobility. Despite improvements in female education over the past two decades, women's labor force participation remains among the lowest globally, hindered by restrictive social norms and insufficient childcare infrastructure (World Bank, 2013; Assaad et al., 2020). Occupational segregation by gender remains pervasive, with women concentrated in unpaid family work or informal service roles. These factors combine to limit intergenerational mobility, as daughters' employment prospects are shaped by both familial expectations and structural barriers.

2.2 Climate Shocks and Labor Outcomes

Literature linking climate variability to labor markets has expanded significantly over the past decade. Temperature fluctuations, rainfall variability, and extreme weather events influence employment and income through multiple channels: agricultural yields, health and productivity, and migration decisions. Empirical evidence shows that extreme heat reduces worker output, particularly in outdoor or manual labor sectors (Dell et al., 2012; Hsiang et al., 2019; Abou-Ali et al., 2023). Similarly, precipitation shocks can alter agricultural income and compel labor reallocation within and across households.

Studies have also highlighted how climatic stressors can alter demographic and economic patterns. Burke et al. (2015) demonstrate that deviations in temperature have nonlinear effects on economic production globally, while Hallegatte et al. (2016) argue that climate change intensifies poverty traps by eroding asset bases and reducing the capacity for recovery. At the household level, short-term responses often include reducing consumption, increasing child labor, or shifting toward informal activities (Rigaud et al., 2018).

In the MENA region, the effects of climate change are particularly severe due to aridity, water scarcity, and dependence on climate-sensitive sectors such as agriculture and construction (World Bank, 2014; IOM, 2022). Egypt faces recurring heat stress and declining Nile flow variability, both of which threaten agricultural productivity and rural livelihoods. Despite these vulnerabilities, research directly linking climate shocks to labor market outcomes in MENA remains limited. Most studies focus on productivity or migration, leaving a gap in understanding how climate events influence intergenerational transitions and long-term inequality.

2.3 Linking Climate Shocks and Intergenerational Mobility

Integrating the two strands of research—on climate impacts and intergenerational mobility—reveals a critical gap in understanding. While we know that climate variability affects short-term employment and income, little is known about how it shapes the persistence of occupation and income across generations. The concept of climate-induced immobility posits that recurring exposure to environmental shocks can lock households into low-income, high-risk occupations by constraining resources for education, skill acquisition, and sectoral diversification.

Several mechanisms explain this intergenerational transmission.

1. Economic mechanism: When extreme weather reduces agricultural yields, household income falls, limiting savings and investment in children's education. This increases the likelihood that children remain in the same occupation as their parents.
2. Health mechanism: Repeated exposure to heat and pollution reduces physical capacity and long-term health, diminishing productivity and narrowing employment options for future generations.
3. Migration mechanism: Climate stress can either encourage or hinder migration. While some households diversify income by sending members to cities, others lack the resources to migrate, remaining trapped in vulnerable regions (Maccini & Yang, 2009; Rigaud et al., 2018).

These dynamics are particularly relevant in Egypt, where the agricultural sector remains heavily dependent on family labor and local ecological conditions. Recurrent heatwaves not only affect crop cycles but also erode intergenerational aspirations, as young adults see diminishing returns from education in contexts where labor markets fail to reward skill acquisition. The resulting equilibrium is one of low mobility and high vulnerability, where both economic and environmental risks reinforce each other.

2.4 The Emerging MENA Perspective

In recent years, a small but growing body of work has begun to address the interaction between climate stress and labor adaptation in MENA. The International Organization for Migration (IOM, 2022) emphasizes that the region's adaptation challenge is not solely technological but also institutional—requiring labor and education systems that can respond to the new realities of climate exposure. Similarly, the World Bank (2014) highlights that climate-induced changes in labor productivity could have cascading effects on poverty and social protection systems.

However, these studies often adopt a macroeconomic or sectoral perspective, missing the micro-level and intergenerational dimensions that define household responses to climate stress. Understanding how parental experiences with environmental shocks translate into children's occupational outcomes provides critical insight into the long-term socioeconomic consequences of climate change.

The current study contributes to this emerging field by empirically estimating how climate anomalies alter occupational inheritance patterns in Egypt. By doing so, it bridges the gap between environmental economics and labor mobility research, highlighting how environmental stressors may not only disrupt markets in the short term but also shape intergenerational trajectories of inequality.

3. Conceptual Framework

The conceptual foundation of this study links climate variability with intergenerational labor market transitions, drawing on theories of human capital transmission, household adaptation, and occupational mobility under environmental stress. The framework posits that climate shocks—defined as deviations in temperature or precipitation from long-term means—affect household welfare and thereby shape decisions that influence children's future employment paths.

3.1 Climate Shocks and Household Economic Decisions

At the core of the relationship between climate and labor lies the household's response to income instability. In Egypt's largely agrarian regions, extreme temperature increases or rainfall deficits directly reduce agricultural yields. When agricultural productivity declines, households face income losses that constrain savings, investment, and consumption (Abd El-Mohsen et al., 2021). The immediate adaptation strategy typically involves adjustments in labor allocation—such as longer working hours, the entry of secondary earners, or temporary migration to urban centers.

These behavioral responses have longer-term consequences for the next generation. For example, children may drop out of school to contribute to family income, or households may reduce expenditure on health and nutrition, leading to lower human capital accumulation. In the absence of compensatory mechanisms like social protection or credit access, such decisions create intergenerational transmission channels through which climate shocks reduce upward mobility.

3.2 Intergenerational Transmission Channels

Occupational persistence across generations occurs through both direct inheritance and indirect socioeconomic transmission. Direct inheritance includes the transfer of family assets such as land, livestock, or farming tools, which tether children to agricultural work. Indirect transmission reflects parental investment in education, skill formation, and social networks that enable labor market entry into non-agricultural sectors (Assaad & Salehi-Isfahani, 2019).

Climate shocks disrupt both pathways. Economic downturns induced by extreme heat or drought reduce the resources available for investment in children's education, limiting the capacity for non-farm transitions. Moreover, environmental degradation can devalue physical assets—such as farmland or irrigation infrastructure—reducing the economic base upon which occupational inheritance depends. Over time, these mechanisms entrench families in low-productivity sectors, reinforcing climate-induced immobility traps.

Mathematically, the intergenerational effect of climate shocks can be conceptualized as follows:

$$Y_{it} = \alpha + \beta_1 ParentOcc_i + \beta_2 Climate_{dt} + \beta_3 (ParentOcc_i \times Climate_{dt}) + \gamma X_{it} + \mu_i + \lambda_t + \epsilon_{it}$$

where Y_{it} is the occupational outcome of individual *i* at time *t*, $ParentOcc_i$ represents the father's occupation, $Climate_{dt}$ captures district-level climate anomalies, X_{it} includes demographic and household controls, and μ_i, λ_t are individual and time fixed effects, respectively. The interaction term (β_3) captures how climate shocks alter the strength of occupational transmission.

A positive β_3 indicates that climate shocks strengthen occupational persistence (e.g., sons are more likely to remain in agriculture), while a negative value suggests that climate stress facilitates occupational mobility—perhaps due to migration or labor reallocation.

3.3 Regional Disparities and Adaptive Capacity

Egypt's geography amplifies heterogeneity in climate-labor dynamics. Upper Egypt, for instance, faces hotter and drier conditions with limited access to irrigation, education, and non-farm jobs. Lower Egypt and the Nile Delta, while benefiting from relatively better infrastructure, are highly exposed to flooding and salinization risks. These spatial variations produce differing levels of adaptive capacity—defined as the ability of households and institutions to adjust to climate stress without suffering long-term losses.

Regions with stronger institutional support (e.g., access to agricultural extension services, credit, and education) are better equipped to manage climate variability. In such contexts, families may respond to shocks by diversifying income sources or investing in education, mitigating intergenerational persistence. Conversely, in areas where adaptive capacity is weak, shocks can have scarring effects that extend across generations.

3.4 Conceptual Summary

In sum, the conceptual model suggests that climate shocks influence intergenerational occupational mobility through intertwined mechanisms of income, health, and asset transmission. These processes are mediated by regional disparities and institutional capacity. The relationship is thus context-dependent, nonlinear, and potentially asymmetric—stronger for poor, rural households and weaker for wealthier, urban ones. The empirical analysis tests these hypotheses by integrating longitudinal household data with spatially matched climate variables.

4. Data

4.1 Data Sources

The empirical analysis combines micro-level socioeconomic data from the Egypt Labor Market Panel Survey (ELMPS) with high-resolution climate data from the NASA POWER database.

a. Egypt Labor Market Panel Survey (ELMPS, 1998–2023)

The ELMPS, jointly administered by the Economic Research Forum (ERF) and Egypt's Central Agency for Public Mobilization and Statistics (CAPMAS), provides nationally representative longitudinal data across five waves (1998, 2006, 2012, 2018, and 2023) (OAMDI, 2024). It collects detailed information on individuals' employment status, education, demographic characteristics, and household assets. Crucially, the survey design allows for linking parents and children either within the same household or across survey waves, enabling measurement of intergenerational labor market transitions.

Occupational data are coded according to the International Standard Classification of Occupations (ISCO), allowing consistent categorization of employment sectors over time. This feature facilitates the identification of occupational transitions—particularly between agriculture and non-agriculture.

b. NASA POWER Climate Data

The NASA Prediction of Worldwide Energy Resources (POWER) dataset provides daily and monthly observations on surface temperature, precipitation, humidity, and solar radiation at fine spatial resolution. District-level averages for Egypt are computed by overlaying the NASA grid with administrative boundaries. The study focuses on mean seasonal temperature and mean seasonal precipitation, along with standardized anomalies (z-scores) that capture deviations from the 1990–2010 baseline.

4.2 Variable Construction

a. Dependent Variables

The study's key outcomes capture both lifetime occupational patterns and intergenerational transitions:

- Persistence in Agriculture: father and son both engaged in agricultural employment.
- Agriculture → Non-agriculture Transition: son moves out of agriculture when the father was an agricultural worker.
- Non-agriculture → Agriculture Transition: reverse movement into agriculture.
- Persistence in Non-agriculture: both generations remain outside agriculture.

b. Climate Variables

Climate indicators are derived at the district level and matched to individuals based on residence. Three main variables are constructed:

Temperature anomaly (°C): deviation of average maximum temperature from the 1990–2010 mean.

To make these anomalies compatible with IPCC global warming thresholds, an adjustment is applied (Hawkins et al., 2017; Morice et al., 2021):

- IPCC 1.5°C ≈ +0.8°C above 1990–2010 levels.
- IPCC 2.0°C ≈ +1.3°C above 1990–2010 levels.

c. Control Variables

Control variables include:

- Individual-level: age, gender, years of education, marital status, and urban/rural residence.
- Household-level: household size, wealth index (constructed via principal component analysis), and dependency ratio.

4.3 Sample and Descriptive Patterns

The final analytical sample includes approximately 22,523 individuals with linked parental information across waves, representing more than 9,000 families. To focus on economically active individuals, the sample is restricted to those aged 15 to 65 years, corresponding to the standard working-age population. Observations outside this age range are excluded using the condition. On average, 44 percent of sons work in the same sector as their fathers, with the majority of persistence occurring in agriculture. The transition rate out of agriculture increased between 1998 and 2012 but plateaued thereafter, aligning with the onset of more frequent extreme heat events post-2010.

Table 1: Interpretation of Panel Round Distribution

Number of rounds	Frequency	Percent	Cumulative %
2 rounds	14,886	66.09%	66.09%
3 rounds	5,493	24.39%	90.48%
4 rounds	1,764	7.83%	98.31%
5 rounds	380	1.69%	100.00%
Total	22,523	100%	

Source: Authors' calculation from ELMPS.

4.4 Climate Exposure Trends

Between 1998 and 2023, Egypt's average summer temperature increased by roughly 1.2°C, surpassing the IPCC 1.5°C warming threshold in several southern governorates such as Aswan, Sohag, and Qena. Precipitation variability also rose, though rainfall levels remain low overall. Districts experiencing recurrent extreme heat events display higher rates of agricultural persistence and slower occupational transition.

These spatial patterns suggest that climate exposure may be reinforcing geographic inequality, with rural southern areas facing both environmental and economic disadvantages. Figures derived from NASA POWER and ELMPS data confirm that regions of high heat exposure overlap strongly with areas of low educational mobility, indicating a potential link between climate stress and intergenerational occupational persistence.

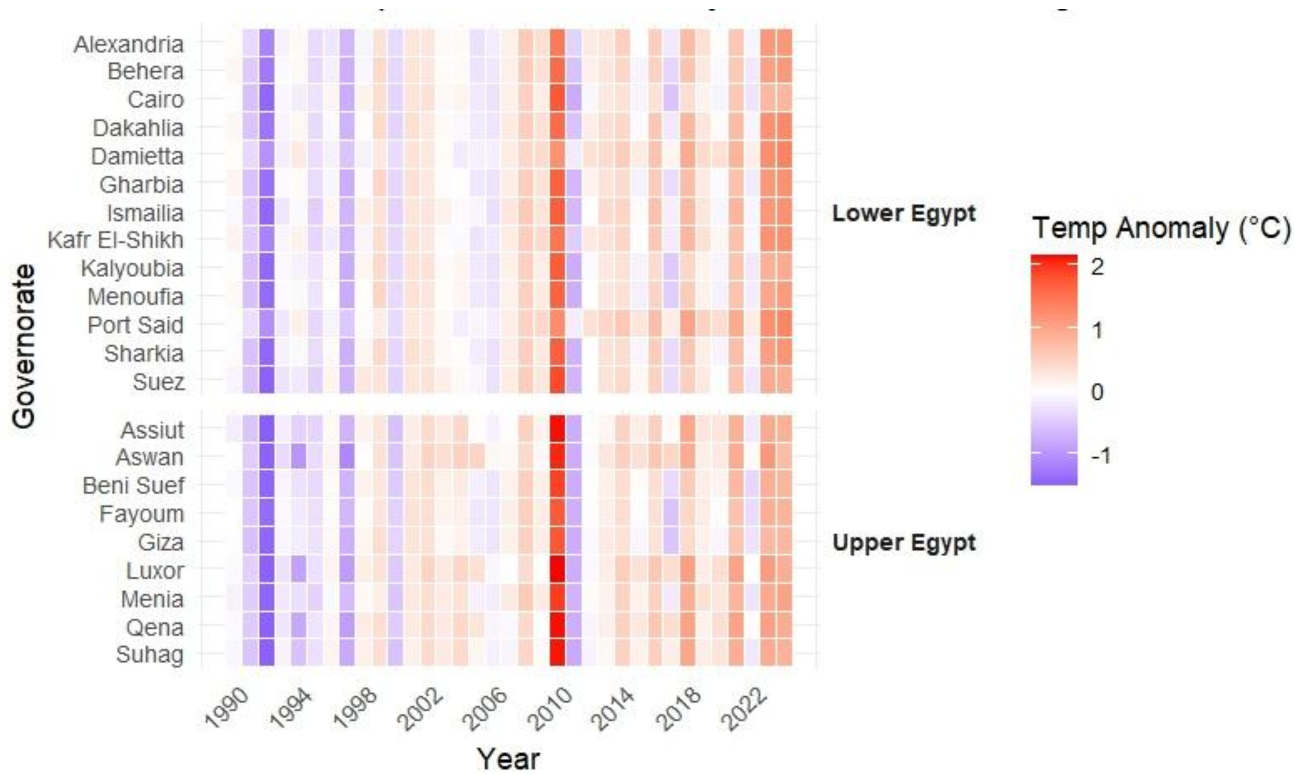

Figure 2: Annual Maximum Temperature Anomalies by Governorate and Region
Source: Authors' calculation based on NASA POWER.

5. Methods

5.1 Econometric Framework

To identify how climate shocks influence occupational persistence and intergenerational mobility, this study employs a two-way fixed effects (TWFE) difference-in-differences (DiD) estimator complemented by an event-study design. These approaches allow for estimating causal effects in the presence of staggered treatment timing and unobserved heterogeneity across individuals and districts.

The baseline specification is:

$$Y_{idt} = \alpha_i + \lambda_t + \beta_1 ClimateShock_{dt} + \beta_2 (ClimateShock_{dt} \times ParentOcc_i) + \gamma X_{it} + \epsilon_{idt}$$

where

- Y_{idt}denotes the labor outcome for individual *i* in district *d* at time *t*;
- $ClimateShock_{dt}$ captures deviations in district-level temperature or precipitation;
- $ParentOcc_i$is a binary indicator equal to 1 if the father was employed in agriculture;
- X_{it} includes individual and household controls (e.g., education, age, gender, wealth index);
- $\alpha_i$and $\lambda_t$are individual and year fixed effects; and
- $\epsilon_{idt}$is the error term.

The interaction coefficient (β_2) measures whether the experience of climate shocks changes the strength of occupational transmission between fathers and sons. A positive value implies reinforced persistence in agriculture, while a negative value suggests that shocks encourage sectoral transition.

5.2 Event-Study Specification

To capture the dynamic effects of exposure and evaluate pre-treatment trends, an event-study model is estimated:

$$Y_{idt} = \alpha_i + \lambda_t + \sum_{k \neq 0} \beta_k EventTime_{k,dt} + \epsilon_{idt}$$

where $EventTime_{k,dt}$represents dummies for the number of periods k before or after the first major heat-shock event. The omitted period ($k = 0$) serves as the reference year. The coefficients $\beta_k$trace the evolution of outcomes relative to the timing of the shock, revealing whether occupational persistence rises or falls in the years following exposure.

This approach addresses potential heterogeneous treatment timing, an issue that biases conventional TWFE estimators (Callaway & Sant'Anna, 2021; Sun & Abraham, 2021). By isolating dynamic responses, the event-study method captures both short-term behavioral adaptation and longer-term intergenerational effects.

5.3 Estimation Details

All models are estimated using Stata 19.5 with the reghdfe estimator, which absorbs multiple fixed effects efficiently. Standard errors are clustered at the district level to account for spatial correlation in climatic variables. Survey weights provided by ELMPS are applied to preserve representativeness.

The analysis proceeds in three stages:

1. Baseline DiD estimation using mean maximum temperature anomalies;
2. Event-study estimation to observe pre- and post-shock trajectories; and
3. Robustness and heterogeneity tests, including gender, rural/urban, and wealth interactions.

5.4 Addressing Potential Biases

Several strategies are used to minimize endogeneity concerns:

- Reverse causality is unlikely because local labor transitions do not influence temperature or rainfall.
- Migration bias is mitigated by controlling for residence status and excluding recent migrants in robustness checks.
- Unobserved regional trends are absorbed using district and year fixed effects.
- Measurement error in climate variables is minimized by averaging over multiple grid points within districts.

The identification assumption is that, absent climate shocks, treated and untreated districts would follow parallel trends in occupational mobility. This is tested through event-study pre-trend coefficients.

6. Results

6.1 Descriptive Patterns

Figure 2 is a visual inspection of ELMPS-NASA merged data reveals pronounced spatial variation. Southern governorates (Aswan, Qena, Sohag) record average summer anomalies exceeding +1.2°C since 2010 and display markedly higher rates of agricultural persistence. By contrast, northern and urban districts exhibit greater sectoral diversification and mobility.

Nationally, 44 percent of sons remain in their fathers' occupational sector. For agricultural fathers, persistence is 52 percent, compared with 23 percent for non-agricultural fathers. Over the 1998–2023 period, total agricultural employment declined from roughly 34 percent to 22 percent of the labor force, but transitions out of agriculture slowed after 2012—coinciding with intensifying heat stress.

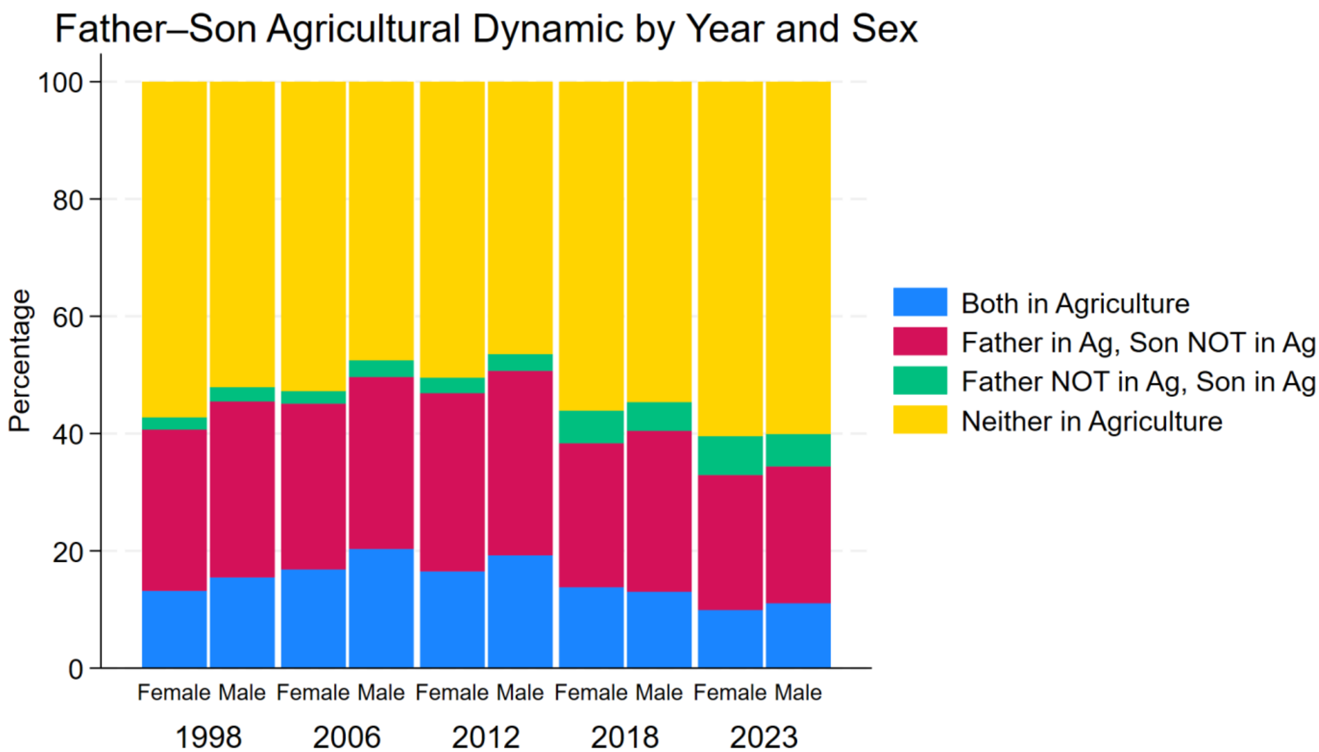

Figure 3: Father-Son Agriculture Dynamic by year and gender
Source: Authors' calculations using ELMPS.

6.2 Event-Study Dynamics

Figure 4 presents event-study estimates of the effect of post-2010 climate shocks on the probability that both father and son are employed in agriculture. Pre-treatment coefficients (1998–2006) are statistically indistinguishable from zero, confirming the parallel trends assumption. Starting in 2010, the probability of intergenerational persistence in agriculture declines steadily, becoming statistically significant and increasingly pronounced over time. By 2023, exposure to climate shocks is associated with a reduction of approximately 12 percentage points in agricultural occupational persistence. This pattern suggests that rising temperatures weakened intergenerational transmission of agricultural employment, consistent with long-term structural shifts away from climate-sensitive sectors.

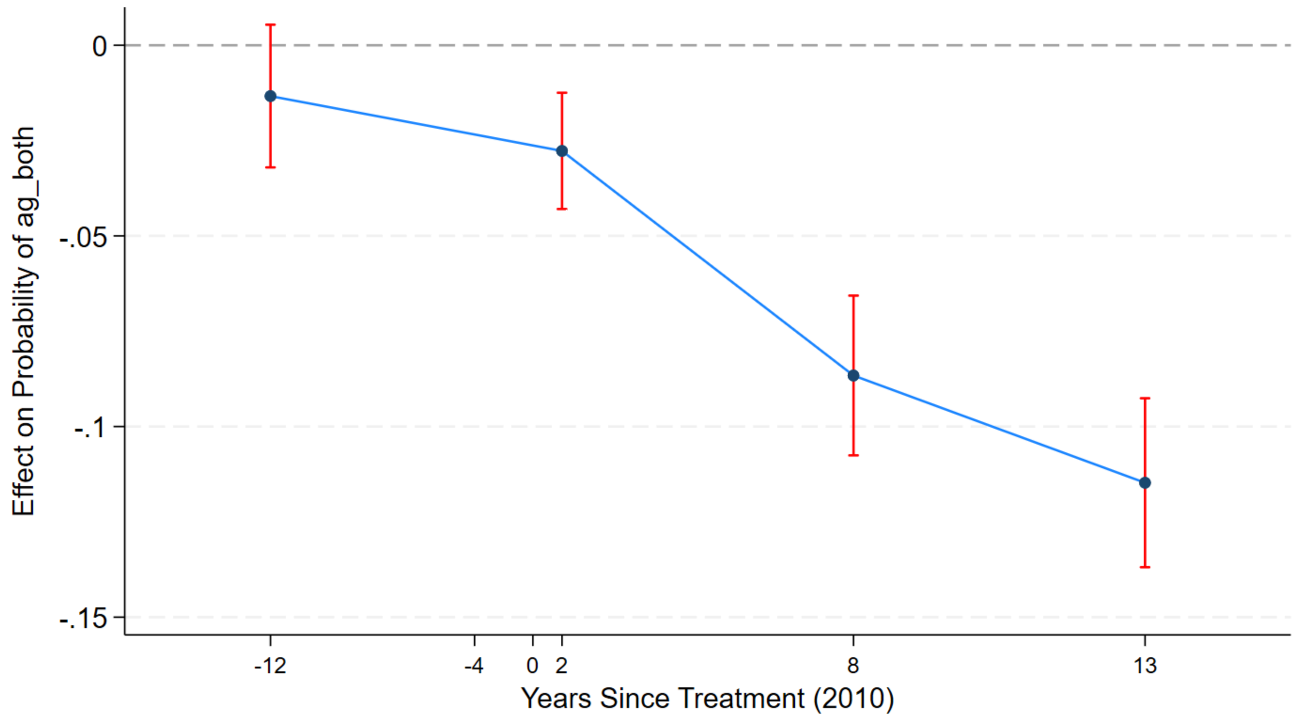

Figure 4: Event Study Estimates for Both-Agriculture
Source: Authors' calculations using ELMPS and NASA POWER

6.3 Interpretation

The findings demonstrate that climate shocks—particularly heat extremes—tend to reinforce intergenerational occupational persistence among Egyptian households, especially within agriculture. Families whose livelihoods are tied to climate-sensitive sectors face restricted capacity to diversify or invest in education when confronted with recurrent weather shocks.

These effects are consistent with theories of poverty traps and climate vulnerability (Hallegatte et al., 2016). They imply that climate change can operate as a mechanism of social stratification: rather than merely lowering current productivity, it perpetuates structural inequality across generations.

The magnitude of the estimated coefficients, though moderate, signals meaningful long-run implications. A two-degree increase relative to baseline—projected for mid-century—could further reduce intergenerational mobility by up to 10 percent if adaptation measures remain limited. Such findings highlight the urgency of integrating climate resilience into labor and social policies.

7. Policy Implications

The results highlight the pressing need for integrated policy responses that address both the direct impacts of climate change on labor productivity and the indirect, intergenerational consequences for social mobility. For Egypt and similar MENA economies, three broad intervention areas emerge: climate-resilient livelihoods, adaptive labor market policies, and equitable social protection systems.

7.1 Building Climate-Resilient Livelihoods

Given the high share of employment in climate-sensitive sectors, climate-smart agriculture (CSA) must form the foundation of rural resilience. Policies should prioritize:

- Investment in adaptive technologies, such as drought-resistant seeds, improved irrigation methods, and precision agriculture;
- Expansion of early-warning and forecasting systems that allow farmers to adjust planting schedules and labor allocation;
- Access to agricultural insurance and credit, which can help households smooth consumption and avoid distress labor decisions following shocks.

Promoting the diffusion of CSA practices through public extension services, cooperatives, and digital platforms would enhance smallholders' adaptive capacity, thereby reducing intergenerational scarring effects of climatic stress.

7.2 Facilitating Structural and Sectoral Transitions

The findings demonstrate that climate shocks entrench workers in low-productivity occupations, especially in agriculture. To counteract this, Egypt needs policies that enable smoother transitions into non-agricultural employment. Key strategies include:

- Investing in rural infrastructure and connectivity to integrate peripheral regions into national labor markets;
- Strengthening vocational and technical education to align skills with emerging green and service sectors;
- Encouraging private sector diversification, including renewable energy, sustainable construction, and logistics, where labor demand is expected to rise under green transitions.

By expanding non-farm opportunities, such policies would allow younger generations to pursue alternative livelihoods even in the presence of localized climate stress.

7.3 Climate-Sensitive Social Protection

The study's findings underscore how climate shocks can erode household welfare and restrict intergenerational opportunity. Egypt's Takaful and Karama cash transfer programs have improved resilience among poor households, but their design could be further enhanced through shock-responsive mechanisms.

Integrating climate early-warning systems into the social registry would enable the government to deploy anticipatory payments or temporary benefit expansions in advance of forecasted heatwaves or droughts. This adaptive social protection framework has been piloted in several African countries and could be replicated in Egypt to prevent climate-induced poverty spirals.

7.4 Education and Human Capital Protection

Sustaining educational investment during and after climate crises is essential to breaking intergenerational immobility traps. Policies could include conditional cash transfers tied to school attendance, scholarships for rural youth, and programs promoting digital and green skills. Ensuring educational continuity during extreme weather events also requires improving school infrastructure, particularly in heat-prone governorates.

7.5 Regional Cooperation and Institutional Coordination

Since climate impacts and labor dynamics transcend national boundaries, regional cooperation is vital. MENA countries share similar vulnerabilities, including water scarcity and youth unemployment, suggesting scope for joint initiatives in data sharing, regional research networks, and cross-border adaptation funds. Institutions like the Arab Coordination Group and the African Climate Policy Centre could facilitate collaborative programs that combine climate adaptation with inclusive employment strategies.

7.6 Implications for Long-Term Equity

The results imply that without intervention, climate change could exacerbate intergenerational inequality by restricting upward mobility for poorer households. Therefore, climate policy must be designed not only to reduce emissions or protect ecosystems but also to preserve social mobility as a form of adaptive justice. Integrating intergenerational equity into climate adaptation frameworks can ensure that future labor markets remain accessible and inclusive even under worsening environmental conditions.

8. Conclusion

This paper examined the relationship between climate shocks and intergenerational labor market transitions in Egypt using longitudinal household data from the ELMPS (1998–2023) and district-level climate indicators from NASA POWER. The results demonstrate that temperature shocks significantly increase occupational persistence in agriculture, particularly among low-income and rural families, suggesting that climate stress deepens structural barriers to social mobility.

By adopting a difference-in-differences and event-study framework, the analysis provided evidence that exposure to extreme heat events reinforces father–son occupational linkage and suppresses transitions out of agriculture. These effects persist for several years, especially in regions with limited adaptive capacity. The results also reveal that the magnitude of climate impacts is mediated by socioeconomic status and geography—indicating that vulnerability is unevenly distributed across Egyptian society.

The findings contribute to the climate economics literature by introducing an intergenerational dimension to climate–labor interactions. Rather than viewing climate impacts as transitory, the study emphasizes their long-term social transmission. Climate change, therefore, is not only an environmental or economic issue but also a mechanism through which inequality is reproduced across generations.

From a policy standpoint, Egypt's challenge lies in designing adaptive strategies that address both immediate labor shocks and structural drivers of immobility. This includes fostering climate-resilient agriculture, expanding non-farm employment, strengthening education and social protection, and embedding climate sensitivity into public policy planning.

Future research could extend this framework to other MENA countries, integrate additional outcomes such as health and migration, and utilize higher-frequency data to capture short-run adjustment processes. Understanding how households adapt—or fail to adapt—across generations remains central to achieving both climate resilience and equitable development in the region.

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