Gendered Effects of Droughts on Agricultural Labour Markets and Spillovers to Other Sectors: Evidence from Chile

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Abstract

This paper studies how drought shocks reshape labour outcomes and how it varies by gender in a diversified upper-middle-income economy highly exposed to climate shocks as Chile. I estimate a multievent event study model for effective hours worked, sectoral employment shares, and employment contract composition with a focus on the agricultural sector that is the most affected by these shocks. I use a comprehensive dataset that includes quarterly labour force survey microdata from the National Employment Survey (ENE) with regional drought measures based on the Standardized Precipitation Evapotranspiration Index (SPEI-3). I then test spillovers in manufacturing and services in regions with higher baseline agricultural dependence and examine internal migration at regional level. Three findings stand out. First, within agriculture, average hours among workers who remain employed change little at drought onset, but women's agricultural employment share falls on impact and men's job stability deteriorates as temporary and limited term contracts rises at medium horizons. Second, severe drought onsets generate sizeable and persistent reductions in manufacturing and especially services hours in regions more agriculture dependent. Third, service spillovers are heterogeneous: consumer services display divergent adjustment by gender, while public and social services show patterns consistent with partial stabilization. Fourth, drought is associated with higher inter-regional migration, but this relationship is attenuated in more diversified origin regions; migration is not strongly predominantly male, and higher out-migration is not associated with improved earnings for women who remain. The results highlight that in diversified labour markets, drought shocks may widen gender gaps primarily through participation, job quality margins and through indirect spillovers beyond agriculture.

Keywords: drought, labour markets, gender, agriculture, migration, Chile.

1. Introduction

Climate change has increased the frequency and intensity of droughts. In agricultural regions, drought is a productivity shock: it reduces yields and farm revenues and can disrupt labour demand, household income, and local non-farm activity. A growing empirical literature shows adverse impacts of weather shocks on wages and employment (Jayachandran, 2006; Mahajan, 2017; Afridi et al., 2022). Yet evidence on adjustment differentiated by gender and on spillovers beyond

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agriculture remains limited, especially in upper-middle-income economies with diversified labour markets and stronger institutions.

Chile offers a useful setting to study these questions. Since 2010, large parts of the country have faced prolonged rainfall deficits and high-water stress, with substantial variation across regions and over time. Agriculture employs a smaller share of workers than in low-income agrarian settings given the country has a diversified economy. However, agriculture remains as a strategic sector in the economy: it contributed 8.6% of GDP and 6.9% of national employment in 2023 (USDA, 2025; Censo Agropecuario, 2025). Between 2013 and 2023, real output in agriculture grew by 18.5%, though with important fluctuations driven by global market dynamics and environmental shocks (ODEPA, 2025). Labour markets are also segmented by gender: women are more concentrated in seasonal agro-industry tasks and in customer services, while men are more represented in construction, transport, and other tradable activities.

This paper studies how severe drought onsets affect labour market outcomes by gender in Chile over 2010-2024. The analysis combines quarterly labour force survey microdata from the National Employment Survey (ENE) with regional drought measures based on the Standardized Precipitation Evapotranspiration Index (SPEI-3) produced by the Center for Climate and Resilience Research (CR2). I estimate multievent event study models that trace dynamic responses around drought onsets for (i) effective hours among employed workers, (ii) sectoral employment shares, and (iii) employment contract composition in agriculture. I then test for spillovers to manufacturing and services in regions with higher baseline agricultural dependence. Finally, using the ENE migration module and complementary income data (ESI), I examine whether drought is associated with internal migration at regional level and whether migration relates to earnings among those who remain.

Three results stand out. First, within agriculture, average hours among workers who remain employed move little at drought onset. Adjustment appears instead on the extensive margin for women: women's agricultural employment share declines on impact. For men, the most robust response is a deterioration in job stability: the share of dependent agricultural workers on temporary and limited term contracts rises at medium horizons, and men's agricultural employment share declines with a delay. Second, drought onsets generate negative spillovers beyond agriculture. In regions more agriculture dependent, manufacturing and services hours start to decline around onset and at medium horizons (roughly one to two years after onset), with service-sector hours remaining depressed at later horizons. Third, service spillovers are heterogeneous across branches and gender. Consumer services display divergent adjustment by gender, transport and communications show episodic and volatile responses, and public and social services show patterns consistent with partial stabilization. On the spatial margin, drought is associated with higher inter-regional migration, but this association is attenuated in more diversified origin regions. Migration is not strongly predominantly male at the regional level, and higher out-migration is not associated with improved earnings for women who remain.

These findings contribute to two debates. First, they show that in diversified economies, drought may widen gender gaps not primarily through contemporaneous wage or hours adjustments within agriculture, but through participation and job quality margins. Second, they document that indirect spillovers can dominate direct responses within sector, and that the composition of local services and public sector capacity shape how shocks propagate.

The rest of the paper is organised as follows. Section 2 reviews related literature and motivates a set of testable propositions. Sector 3 states the theoretical framework. Section 4 describes the data and variable construction. Section 5 presents the empirical strategy and main findings. Section 6 discusses mechanisms. Section 7 interprets the results and draws implications for policy and future work. Section 8 concludes.

2. Literature review

A large body of literature shows that drought shocks depress rural earnings and employment. Drought is fundamentally a productivity shock to agricultural production, and in turn it disrupts labour markets through multiple channels. When crops fail or yields drop, farm revenues decline and the demand for agricultural labour contracts. This adjustment can occur both through fewer paid hours or days worked among continuing workers and through reductions in headcount via layoffs or non-renewal of seasonal contracts, often with gendered incidence given task segmentation. At the same time, farming households must cope with lost income, which can alter their supply of labour to both farm and non-farm activities (e.g. Jayachandran, 2006; Afridi et al., 2022).

Thus, the natural question from the supply side is how households accommodate income shortfall by reoptimizing work, potentially leading to persistent and widespread effects across sectors on wages and employment. Early empirical work on weather shocks offers critical insights. Jayachandran (2006) explains that unexpected rainfall declines in rural India cut wages especially for poorer and credit constrained households who cannot migrate or diversify their income sources. Using Brazilian data, Mueller and Osgood (2009) show that severe droughts create wage losses that last for years, partly because households liquidate productive assets to smooth consumption. Mueller and Quisumbing (2011) examine the 1998 Bangladesh flood and find that real wages fell across sectors but that losses were smaller where non-farm employment was accessible. Burgess, Deschenes, Donaldson, and Greenstone (2011) highlight similar mechanisms for temperature shocks and agricultural productivity. Taken together, this evidence motivates looking beyond average employment levels to the specific margins through which labour markets adjust, especially paid hours in affected sectors and short run discontinuities in seasonal work.

This prior literature has largely centred on aggregate results; however, a growing body of evidence demonstrates that weather shocks, in particular drought impacts, are not gender neutral. When a drought happens, women often hold more precarious jobs than men, face mobility constraints and care burdens, and encounter barriers to switching sectors (Mahajan, 2017; Eastin, 2018; Afridi, Mahajan, & Sangwan, 2022). Together these studies establish that drought shocks are an important

driver of wage and employment volatility, and that women's and men's recovery depends on market access and mobility. In particular, women's workdays in India fall by about 19% relative to men's in drought years because men diversify into non-farm jobs or migrate, while women face mobility constraints (Afridi et al., 2022; Eastin, 2018). Distress labour margins also exist. When household income falls, some women may enter low paid work as a last resort (Bhalotra, 2010), but time poverty during droughts (more hours fetching water, fuel, and caregiving) can reduce women's ability to supply paid labour (WHO, 2014; WEDO, 2008; Van Aelst & Holvoet, 2016). This evidence derives primarily from developing economies with high dependence on agriculture.

Far less is known about how droughts reshape sectoral labour markets by gender in upper-middle-income countries with diversified economies and employment structures. Evidence is limited on supply side responses, particularly on how cross sector spillovers and labour reallocation intersect to reshape gendered labour outcomes (Afridi, 2022). Moreover, there are no studies providing disaggregated evidence by gender for upper-middle-income countries with diversified labour markets that quantify how drought shocks translate into persistent gender gaps in participation, earnings, cross sector spillovers, and labour reallocation. In these settings, adjustment may operate less through immediate wage cuts and more through changes in employment composition, contract renewal, and sectoral reallocation. This gap is especially relevant in countries where agriculture is embedded in diversified, connected economies and continues to employ a large share of vulnerable workers (low-income households, women, and migrants). Consequently, persistent gender differences in paid work and mobility restrict how households adjust, leaving substantial scope to advance climate resilience and the inclusion of vulnerable groups in these contexts.

In this context, it is relevant to review the literature of two interrelated dimensions through which drought shocks can reshape labour supply: (a) supply responses, and (b) spillovers and labour reallocation.

2.1 Supply-side responses

From the supply side, rural households facing a drought and income loss need to decide how to adjust their work efforts as developing countries do, but the type and intensity of the adjustment could differ, giving space to study this gap in the literature. Existing evidence and institutional features of upper-middle-income, diversified economies suggest that women may experience sharper employment and income losses than men during droughts, not because of a lack of jobs in the economy, but because segmentation and mobility barriers bind more tightly for women. This framing maps directly to paid hours and employment continuity outcomes, where drought can reduce women's paid hours even among those who remain employed, and can also increase job separations in seasonal roles.

These economies might offer women relatively more opportunities than lower-income agrarian settings. Women are more likely to have formal schooling, access to non-agricultural employment, and reside in diversified economies where jobs exist beyond farming (World Bank, 2024; Herrendorf, Rogerson & Valentinyi, 2014; Ngai & Petrongolo, 2017). In principle, this should enable women to adapt more easily than in low-income settings. Yet in practice, women still

remain heavily concentrated in seasonal and labour intensive agricultural and agro-industrial tasks, such as fruit picking, sorting, and packing, which are among the first to contract when drought reduces yields, given the temporary contracts (Barrientos & Visser, 2012; FAO, 2023). Men, by contrast, may be better positioned to reallocate into construction, transport, or mining, sectors less directly tied to water intensive agriculture (ILO, 2024; ILO, 2020; Nawrotzki, Riosmena & Hunter, 2016; Afridi et al., 2022). One implication from the literature is that fewer men competing for the remaining jobs could help buffer male wages from falling. A second implication is that women's relative immobility means they absorb more of the shock locally, either through outright job loss or by staying in low paying activities. This means that drought shocks can still displace women disproportionately from paid work, even when other jobs exist in the broader economy. Preliminary research supports this. In Chile, drought exposure has been found to significantly reduce women's labour income and employment, with especially large impacts on indigenous women. Affected women were more likely to become unpaid family workers or exit the labour force (Perez-Silva et al., 2023).

A natural extension of this discussion concerns the persistence of the effect, which remains a less underexplored gap in literature in this kind of setting. Empirical evidence from developing countries indicates that such effects are often more enduring, primarily due to limited adaptive capacity (Afridi, 2022). In upper-middle-income economies, however, the labour market impacts of droughts may be more transitory in aggregate yet heterogeneous by gender, reflecting structural diversification and adaptive mechanisms within agriculture. In these types of economies, households often have more options. Family members may supplement lost farm income with off-farm employment in local services or industry, and regional diversification means that drought does not hit all areas equally. Thus, these adaptive strategies are not gender neutral. Men are more likely to take advantage of wage differentials by moving across sectors or regions, for example migrating temporarily to urban construction or manufacturing jobs. Women, by contrast, face higher constraints on mobility and time use (Afridi et al., 2022). As a result, women absorb the shock through increased unpaid household labour. Accordingly, two implications follow. First, men's earnings and employment partly recover through diversification across sectors and regions, so household income losses and declines in employment rates are less persistent. Second, women's paid hours fall even as total workload rises, and employment rates in regions hit by droughts recover more slowly than men, reflecting constraints on mobility. Therefore, in upper-middle-income economies, droughts can accelerate structural change at gender level: transitory in aggregate earnings and employment rates, yet persistent in widening gender gaps.

2.2 Spillovers and reallocation

From a spatial sectoral reallocation perspective, droughts propagate beyond agriculture by depressing farm incomes and, in turn, demand for local non-tradables. Evidence shows that repeated droughts in Brazil reduced employment and wages in services and manufacturing, consistent with spillovers and operational constraints, while households tried to buffer losses through multi job holding and shifts into non-farm activities (Bastos et al., 2013; Branco & Feres,

2021; Albert et al., 2021). This motivates a focus on paid hours adjustments outside agriculture, especially in sectors where firms can quickly scale shifts and days worked in response to local demand contractions.

These patterns imply that contractions in agricultural income induced by droughts can translate into larger reductions in women's paid employment and earnings than men's in upper-middle-income economies, not only in agriculture but also in local services and manufacturing, because mobility constraints and rising unpaid workloads bind more tightly for women. When drought depresses spending in affected regions, businesses linked to agriculture (e.g., processing, transport, retail, restaurants) cut wages or jobs. Women, who are less likely to migrate or work outside their village and whose time is diverted toward unpaid tasks when resources become scarce, have fewer pathways to offset these local contractions (Afridi et al., 2022; WHO, 2014; WEDO, 2008). Men, by contrast, are relatively better positioned to reallocate within or beyond the region. This derives two implications. First, in regions hit by droughts, women's paid hours and employment are more likely to fall in both agriculture and locally tied non-farm activities, amplifying the initial shock (Bastos et al., 2013). Second, household adjustments (e.g., multi-job holding) occur but do not fully compensate for women if unpaid demands rise and mobility is constrained (Branco & Feres, 2021; Afridi et al., 2022; WHO, 2014; WEDO, 2008). This sectoral propagation by gender in upper-middle-income settings remains an underexplored gap in the literature.

A second channel is spatial reallocation through migration. A body of literature has studied this phenomenon across countries, but less is known within country. Evidence shows that regions affected by droughts have increased youth migration within Central America and the Caribbean and raised international migration from Mexico when climate shocks reduced yields (Baez et al., 2017a, 2017b; Feng, Krueger, & Oppenheimer, 2010). Out-migration can further depress local demand but may ease wage pressure for those who remain. Same logic is expected in migrations across regions in a country. These flows are often gendered, reflecting that men tend to be more likely to migrate due to social norms, networks, and lower mobility constraints, while women may face barriers to moving and are more likely to remain in local labour markets (Afridi et al., 2022; Eastin, 2018). In upper-middle-income economies, overall migration responses remain more limited than in lower-income agrarian settings because the economy is more diversified, but migration can still function as a residual margin when local labour markets are highly concentrated. Consistent with this view, internal migration should be less prevalent from origins with more diversified employment structures, where local reallocation can absorb workers without requiring residential moves. Moreover, out-migration need not increase local earnings for those who remain; if demand is depressed economy wide within the region, earnings effects can be muted or even negative, particularly for women.

In sum, the literature shows that droughts depress earnings and employment and that adjustment is gendered, but there is a lack of joint evidence on direct effects, spillovers, and recovery dynamics in upper-middle-income, diversified economies. This motivates an integrated empirical approach that tests direct agricultural adjustment (hours, employment continuity, and wages), local

spillovers in paid hours outside agriculture, the mechanisms behind those spillovers, and internal migration as a residual adjustment margin. The next section organises these insights into a theoretical framework and states four testable propositions.

3. Theoretical framework

Drought acts as a productivity shock that works through both production and labour markets. In the agricultural sector, lower water availability depresses agricultural output, shortens harvest windows, and reduces packhouse volumes. In response, from the labour demand side, farm employers may adjust the intensive margin by reducing hours among existing workers: shorter shifts, fewer days per week, overtime cuts, seasonal downtime. If that proves insufficient, they move to the extensive margin, reducing headcount: temporary layoffs, non-renewal of seasonal contracts, slower hiring, and wages fall where pay is flexible.

On the supply side, households face an income shortfall and re-optimize who works, where, and for how long. People respond to incentives, but they do so under unequal constraints and expectations. Consequently, responses are not gender neutral. In many contexts, men can pivot toward construction, transport, logistics, or other tradables when farm work dries up. Women, more often located in seasonal agro-tasks and bearing disproportionate care and unpaid duties, face higher mobility costs and tighter time budgets. The same signal therefore generates different labour supply responses by gender, even when the underlying demand shock is common (Jayachandran, 2006; Afridi, Mahajan, & Sangwan, 2022). In upper-middle-income settings, hours among continuing workers can be relatively rigid in more formal jobs, so part of adjustment occurs through contract renewal and employment composition; however, in flexible segments, especially local services, paid hours can adjust quickly, consistent with spillovers based on hours outside agriculture. Thus, this framework is designed for upper-middle-income and diversified economies where agriculture is tightly linked to services and manufacturing, and where gender gaps present an opportunity to advance toward more equitable development.

(a) How drought moves wages and jobs: the demand side and local general equilibrium

A drop in yields shifts agricultural labour demand inward. Adjustment begins on the intensive margin, with shorter shifts and fewer days in harvesting, sorting, and packing. If pressure persists, employers move to the extensive margin by reducing headcount, while wages fall where pay is flexible. The initial demand contraction then propagates to local non-tradables. Lower farm income suppresses demand at shops, restaurants, repair services, and small processors. With thin credit and small firm size, these businesses decrease hours and wages rapidly, transmitting the agricultural shock across the local economy (Bastos et al., 2013; Albert et al., 2021). At the same time, diversified local structures provide non-agricultural outside options (e.g., construction, logistics, manufacturing) that can absorb workers out of agriculture within the same region or through short distance commuting, thereby reducing the need for residential migration. Any wage effects of out-migration are not mechanical: when drought coincides with broader regional downturns, weakened labour demand can dominate, muting or even reversing earnings gains for those who remain, particularly for women. These non-agricultural spillovers can arise through two

distinct channels: (i) reduced local spending, which primarily contracts non-tradable consumer services, and (ii) production linkages with agriculture, which primarily affect intermediate and producer services tied to farm volumes and trade. Public and socially provided services are partly budget and institutionally stabilized, so their hours may contract less during the adjustment period.

(b) How households adjust: the supply side

Households then translate these market signals into labour supply choices subject to time, mobility, liquidity, and norms. The income effect of lost earnings pushes households to increase market work, but the substitution possibilities differ sharply by gender. For men, outside options in tradables and longer distance commuting reduce their effective reservation wage for non-farm jobs. For women, time poverty induced by care needs raises the shadow price of time at home, lifting reservation wages for market work and constraining hours precisely when the household needs them most (WHO, 2014; WEDO, 2008; Van Aelst & Holvoet, 2016). Therefore, search and mobility frictions are also gendered. Commuting and migration carry higher social costs for women, reducing their response to new vacancies (Afridi et al., 2022). Mobility frictions can also shape the form and distance of mobility rather than implying strongly male biased migration. Men may be more likely to undertake solo or longer distance moves, while women's mobility is more often household linked and constrained in timing, so aggregate regional migration need not appear predominantly male.

Segmentation matters as well. Women are concentrated in seasonal, piece rate agro-industry roles with irregular hours and weak recall, while construction, logistics, and transport typically hire year-round through contractor arrangements, making adjustment on those margins more accessible to men. The net result is asymmetric adjustment: men more often reallocate across sectors and space, while women are more likely to adjust through exits or reduced paid work and more localized or household linked moves, with some entry into low paid distress jobs, though that margin is limited by time and mobility constraints (Bhalotra, 2010).

This paper focuses on these supply-side adjustments (entry, exit, hours, and sectoral/spatial reallocation by gender) while using demand side movements as the exogenous impetus.

(c) Why aggregates can be transitory while gender gaps persist: dynamic adjustment

In upper-middle and diversified economies, aggregate employment and earnings can rebound as workers reallocate and as firms in tradables expand. Yet gender gaps in paid work widen for two connected supply side reasons. First, sequencing. The roles that shrink earliest are seasonal and more focused on women; recall is slower and more uncertain for those positions. Second, unequal reallocation. Men's feasible choices span sectors and space, while women's choices are more local and time constrained, which limits their labour-supply elasticity with respect to new opportunities. The resulting pattern can be transitory at the aggregate but persistent in gender gaps, following directly from demand shocks interacting with gender differentiated constraints. This persistence may show up as short run exits and delayed re-entry for women, and as a deterioration in job stability (for example, more limited term contracting) rather than only reductions in hours.

Based on this framework, the following propositions proceed in sequence:

P1 - Direct agricultural adjustment (impact): Drought shifts agricultural labour demand inward. Adjustment may occur on the intensive margin (hours) and, if pressure persists, on the extensive margin (headcount); posted wages fall where pay is flexible. Because seasonal and contingent tasks adjust first, women who are often over-represented in these roles are expected to experience larger immediate reductions in agricultural employment and job continuity, while average hours among those who remain employed may adjust less.

P2 - Local spillovers (impact): Drought onsets in regions more agriculture dependent weaken local demand and short-run production linkages, generating spillovers to non-agricultural activities (manufacturing and services) through reductions in paid hours. These spillovers should be stronger in regions with higher baseline agricultural dependence and may be gendered if women face tighter mobility constraints on switching sectors.

P3 - Spillover mechanisms: If drought spillovers operate mainly through local demand, the largest hour reductions should appear in non-tradable, consumer facing services (e.g., retail and hospitality), where revenues depend on regional spending. If spillovers operate mainly through production linkages with agriculture, effects should be more pronounced in intermediate or producer services (e.g., transport/logistics, business services) that service agricultural production and trade. Public and socially provided services may partially stabilize local labour markets and therefore display weaker contractions, or even compensating increases in hours, during the adjustment period.

P4 - Migration as a residual margin: Internal migration acts as a residual adjustment margin because it becomes more likely when local labour markets offer limited and poorly diversified employment opportunities. Regions with more diversified employment structures can adjust locally, reducing the need to migrate. Therefore, migration could be not strongly male biased, reflecting household rather than decisions specific by sector, and out-migration does not necessarily raise the earnings of those who remain because it often coincides with adverse regional shocks that depress local labour demand, leading to muted or even negative earnings effects, particularly for women.

The size of these gender differentiated responses is heterogeneous across regions. Effects intensify where agriculture's local income share and input-output linkages are larger; where wage rigidity pushes adjustment onto headcount/hours (employment gaps) rather than wages (wage gaps); and where access to construction/mining/logistics increases male outside options faster than female ones; increasing gaps even if the drought shock is unchanged.

The paper's contribution is to estimate these margins jointly and in sequence in a diversified economy. It quantifies the direct agricultural impact and job quality adjustment within agriculture; measures the local general equilibrium propagation of the shock into services and locally tied processing; uses heterogeneity within services to probe propagation mechanisms; and traces spatial adjustment through internal migration and its distributional correlates. This study offers an

integrated, gender aware account of adjustment in diversified labour markets that existing work has not analysed jointly, centring the supply side.

4. Data and variable construction

4.1 Labour market data

The analysis uses a panel dataset at region level on labour market outcomes and drought shocks in Chile for 2010-2024. This window overlaps with the severe drought episodes experienced since 2010 in the country and provides substantial rainfall and moisture deficit variation across regions and quarters.

The main dataset is the National Employment Survey (ENE), a household labour force survey produced by the National Statistics Institute in Chile (INE). The ENE is a continuous survey with national coverage and a probabilistic, stratified, two stage sampling design. Primary sampling units are geographic clusters (UPM), and dwellings are second stage units (USM) selected with equal probability within the chosen UPMs. ENE coverage includes households in all administrative regions and reaches most municipalities (around 97%). The survey is representative at regional and national levels, so this paper treats regions as the relevant labour market unit and constructs region level estimates using official survey weights.

A key advantage of the ENE for analysing short run adjustment is its rotating panel structure. Dwellings are interviewed for up to six rounds over 18 months, with interviews spaced at three-month intervals. Official labour market indicators are published as moving quarters. Accordingly, I organise ENE microdata at the region-quarter level (and disaggregated by gender), matching the temporal structure of drought exposure.

For outcomes that require linking individuals over time (e.g., short run sector switching), the rotating panel is used to link workers observed in consecutive rounds (t and t+1). I use these linked records only where cell sizes are sufficient and interpret them as complementary evidence.

4.2 Outcomes and covariates

The baseline intensive-margin outcome is effective hours worked, defined as weekly hours worked in the reference week. I aggregate hours to weighted means across employed workers within cells defined by region, quarter, gender, age group, and education. I use an age bracket of three life cycle (15-30, 31-45, and 46-65) and two education groups (tertiary versus non-tertiary). Conditioning on age and education helps reduce compositional shifts in skill and life cycle structure within region-quarter-gender cells.

Sectoral outcomes are constructed using the ENE industry classification for the main job. I define three broad sectors: (i) agriculture, (ii) manufacturing, and (iii) services. The extensive margin is measured as the share of employed workers whose main job is in each sector, computed within region-quarter-gender-age-education cells.

Job quality is proxied through contract structure among dependent employees. Using ENE contract variables, I measure whether the employment relationship is open-ended or fixed-term, and I construct the share of dependent agricultural workers on limited term contracts (in percentage points). Where relevant, I also use the reported reason for time limitation, i.e. seasonality, completion of a specific job or project, very short duration, renewable fixed-term arrangements, and replacement contracts.

For the disaggregated analysis of the service sector, I partition services into four branches using the ENE activity classification: (1) consumer market services (wholesale/retail trade and hotels/restaurants), (2) transport/communications, (3) producer/business services (financial intermediation and real estate/business activities), and (4) public and social/personal services. This decomposition is intended to be informative about plausible demand exposure and linkages, not a definitive tradability classification.

4.3 Earnings data

Earnings are measured using the Complementary Income Survey (ESI), an income module embedded within the ENE and fielded once per year in the October-December quarter. I measure labour income as total income from work, expressed in real terms using the Consumer Price Index (CPI). Given that ESI is fielded annually, I implement earnings analyses on region-quarter-gender-age-education cells and interpret them as complementary evidence.

4.4 Migration and local economic structure

Internal migration is measured using the ENE migration module, which asks individuals where they lived five years earlier. An individual is classified as an internal migrant if their current region differs from their region of residence five years earlier. The origin is the region five years earlier and the destination is the current region.

Local opportunity diversification is measured at the origin region-year using a concentration index built from the sectoral distribution of employment. Specifically, the diversification index equals one minus the Herfindahl-Hirschman index of sectoral employment shares, so higher values indicate more evenly distributed employment across sectors. Out-migration pressure is the origin region-year share of migrants.

4.5 Drought exposure

Drought exposure is measured using the Standardized Precipitation Evapotranspiration Index (SPEI) from CR2. The SPEI standardises a climatic water balance measure combining precipitation and potential evapotranspiration. Given that it incorporates evaporative demand, SPEI is well suited for climate impact analysis relative to indices only focus on rainfall. I use a three-month accumulation window (SPEI-3), which aligns with ENE moving quarters and captures short run moisture deficits relevant for labour market adjustment.

Formally, SPEI is constructed from the climatic water balance $D_t = P_t - PET_t$. The series D_t is first aggregated over a 3-month window, and for each regional location and calendar month the

historical distribution of this 3-month D is fitted, commonly using a three-parameter log-logistic distribution. The fitted cumulative probabilities are then mapped to a standard normal variable, so SPEI values can be interpreted as standardised deviations of recent 3 months moisture conditions relative to the local historical distribution for that time of year.

SPEI is centred at zero, with negative values indicating drier-than-normal conditions. Following common thresholds, I classify severe drought as SPEI-3 <= -1.5 and extreme drought as SPEI-3 <= -2. In the main analysis, drought onset is defined as a threshold crossing: the first quarter in which SPEI-3 falls below the severe threshold after being above it in the previous quarter. Labour responses are more plausibly triggered when climatic stress becomes sufficiently intense to affect production decisions, labour demand, and household coping strategies, rather than responding linearly to small fluctuations around normal conditions.

5. Baseline specifications and findings

5.1 P1: Direct agricultural adjustment

Baseline multievent event-study design

To study dynamic adjustment around drought onset, I estimate a multievent event-study design at the region-quarter level. Let r index regions and t index quarters. A drought onset is defined as the first quarter in which SPEI-3 crosses below a severe threshold τ after being above it in the previous quarter:

$$\mathrm{D_{rt}} \;=\; 1\{\,\mathrm{SPEI_{\{r,t\}}} \le \tau \text{ and } \mathrm{SPEI_{\{r,t-1\}}} > \tau\}, \text{with } \tau \;=\; -1.5$$

I then construct event-time indicators for quarters k relative to onset and estimate, separately by gender g, the following specification on collapsed cells defined by region, quarter, gender, age group, and education group:

$$Y_{rtgae} = \sum_{k\ in\ K, k\neq -1} \beta_{\mathrm{k,g}} * 1\{\text{event time} \;=\; k\} \;+\; \alpha_{\mathrm{t}} \;+\; \gamma_{r,a,e,q(t)} \;+\; \varepsilon_{rtgae}$$

In the baseline implementation, the event window spans five quarters prior to onset and ten quarters after onset (k = -5,...,10), with k = -1 omitted as the reference period. The omitted period is k = -1, the quarter immediately preceding onset. The coefficients $\beta_{\mathrm{k,g}}$ trace dynamic effects relative to the pre onset baseline. Quarter fixed effects α_{t} absorb nationwide shocks. The term $\gamma_{r,a,e,q(t)}$ denotes region-age-education-quarter fixed effects that flexibly control for persistent group specific seasonality within regions. All regressions use sampling weights and cluster standard errors at the regional level (16 clusters). Lead coefficients provide a pre-trend diagnostic, and I report joint tests of the leads.

P1 Findings

Table 1 show that severe drought onsets are followed by little change in average hours among workers who remain employed in agriculture, but by a short-run contraction in agricultural

employment, especially for women. The pre-onset coefficients are close to zero, and the post-onset effects are small relative to baseline levels of agricultural hours (about 36-40 hours per week) and employment shares (about 4-10%).

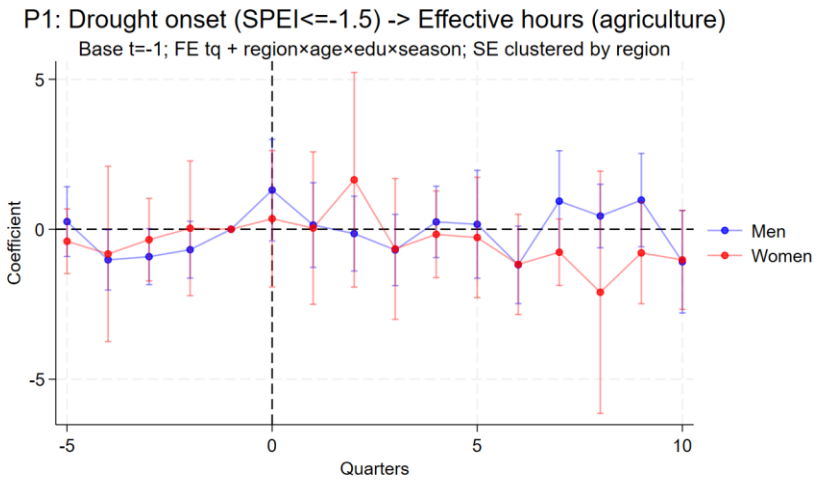
Table 1: Intensive and extensive margin

Event time (quarters)	Intensive margin		Extensive margin	
	Men	Women	Men	Women
t=-5	0.255	-0.402	0.003	-0.002
	(0.593)	(0.551)	(0.004)	(0.003)
t=-4	-1.021**	-0.824	0.001	-0.006**
	(0.513)	(1.492)	(0.003)	(0.003)
t=-3	-0.914*	-0.348	0.004	-0.004*
	(0.476)	(0.702)	(0.004)	(0.002)
t=-2	-0.682	0.033	0.008**	-0.002
	(0.485)	(1.146)	(0.004)	(0.002)
t=-1 (base)	0.000	0.000	0.000	0.000
t=0	1.306	0.350	-0.003	-0.010***
	(0.864)	(1.162)	(0.002)	(0.003)
t=1	0.141	0.040	-0.003	-0.007**
	(0.721)	(1.297)	(0.002)	(0.003)
t=2	-0.146	1.649	0.001	0.001
	(0.637)	(1.826)	(0.003)	(0.002)
t=3	-0.690	-0.656	-0.004	-0.004
	(0.606)	(1.198)	(0.004)	(0.003)
t=4	0.245	-0.169	-0.008***	-0.003
	(0.608)	(0.738)	(0.003)	(0.005)
t=5	0.165	-0.276	-0.005	-0.001
	(0.919)	(1.025)	(0.004)	(0.003)
t=6	-1.187*	-1.172	0.002	0.006*
	(0.660)	(0.853)	(0.005)	(0.003)
t=7	0.937	-0.766	0.000	0.001
	(0.858)	(0.565)	(0.003)	(0.004)
t=8	0.441	-2.102	0.001	0.002
	(0.541)	(2.061)	(0.004)	(0.004)
t=9	0.971	-0.789	0.006	0.005
	(0.793)	(0.865)	(0.007)	(0.004)
t=10	-1.084	-1.021	0.005	0.005
	(0.871)	(0.843)	(0.005)	(0.006)

Notes: Coefficients with significance stars (* p<0.10, ** p<0.05, *** p<0.01). Cluster-robust SE in parentheses. Base period t=-1 normalized to 0. Observations for intensive margin (cells): Men=5434, Women=4808. Observations for extensive margin (cells): Men=5760, Women=5760.

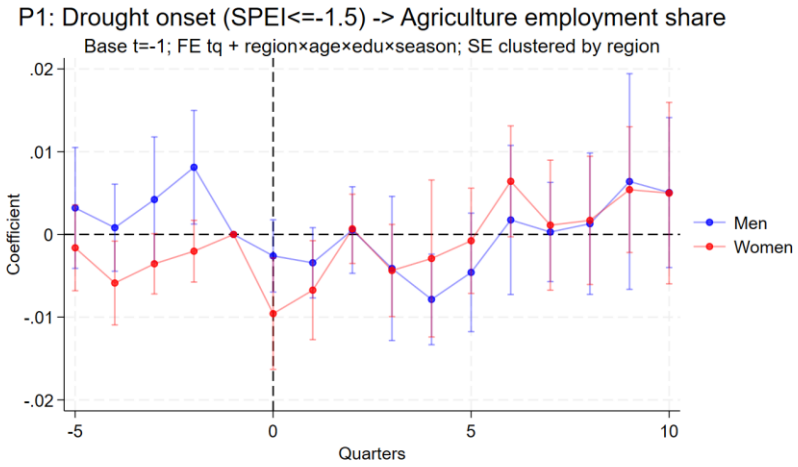
Figure 1 shows the estimates for intensive margin. Hours profiles are tightly centred around zero for both men and women. There is no evidence of a sharp contemporaneous reduction in hours in the quarters immediately after onset. Point estimates rarely exceed about one hour in magnitude, and confidence intervals typically include zero. This suggests that, conditional on remaining employed in agriculture, adjustment along the intensive margin is limited at quarterly frequency.

Figure 1: Intensive margin



For the extensive margin, employment shares respond more clearly and with different timing by gender. Women's agricultural employment share falls at onset by about 1 percentage point and remains lower in the subsequent quarter. Men's agricultural share declines later, with the largest reduction around one year after onset (about 0.8 percentage points). The effects then attenuate. Given baseline agricultural employment shares, these movements are economically meaningful and indicate that short run adjustment operates mainly through participation and sectoral allocation rather than hours per worker.

Figure 2: Extensive margin



Complementary evidence on posted wages in agriculture

To assess if posted wages fall where pay is flexible, I focus on employed individuals in agriculture and construct an hourly wage proxy as monthly labour income divided by effective hours worked. Given that ESI wages are observed only in the October-December quarter, event-time identification is more limited.

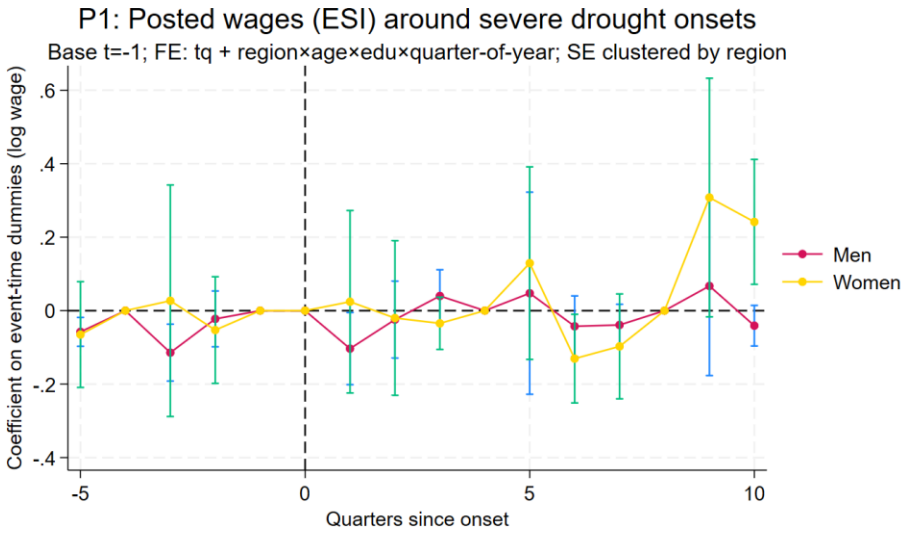
Using the ESI wage proxy, Table 2 and Figure 3 show the estimations. I do not find a systematic post-onset decline in hourly labour income in agriculture. Estimated wage changes around onset are small and unstable, and any visible movements are not concentrated in the quarters after onset. Taken together, the ESI evidence provides limited support for sharp posted-wage adjustment and is consistent with the ENE results pointing to employment reallocation as the main short run margin.

Table 2: P1 wages

Event time (quarters)	Men	Women
t=-5	-0.058***	-0.065
	(0.020)	(0.073)
t=-4	0.000	0.000
	(0.000)	(0.000)
t=-3	-0.114***	0.027
	(0.039)	(0.161)
t=-2	-0.022	-0.053
	(0.039)	(0.074)
t=-1 (base)	0.000	0.000
t=0	0.000	0.000
	(0.000)	(0.000)
t=1	-0.103**	0.024
	(0.050)	(0.127)
t=2	-0.024	-0.020
	(0.053)	(0.107)
t=3	0.040	-0.034
	(0.036)	(0.036)
t=4	0.000	0.000
	(0.000)	(0.000)
t=5	0.048	0.129
	(0.140)	(0.134)
t=6	-0.043	-0.131**
	(0.042)	(0.062)
t=7	-0.039	-0.097
	(0.029)	(0.073)
t=8	0.000	0.000
	(0.000)	(0.000)
t=9	0.067	0.308*
	(0.124)	(0.166)
t=10	-0.041	0.242***
	(0.028)	(0.087)

Notes: Coefficients with significance stars (* p<0.10, ** p<0.05, *** p<0.01). Cluster-robust SE in parentheses. Base period t=-1 normalized to 0. Observations (cells): Men=3621, Women=2709.

Figure 3: P1 wages



5.2 P2: Local spillovers beyond agriculture

P1 suggests that within agriculture intensive adjustment is modest at quarterly frequency. P2 therefore tests whether drought shocks propagate to the rest of the regional economy through local linkages, particularly via reduced agricultural income and local demand.

To test for spillovers, I estimate a multi-event event-study design for non-agricultural outcomes and allow the dynamic response to differ by baseline agricultural dependence. Let HighAg_r be an indicator for regions above the median baseline agricultural employment share (measured over 2010-2012). For each non-agricultural sector s in manufacturing, services and gender g, I estimate:

$$Y_{rtgae} = \sum_{k \neq -1} \beta_k * 1\{\text{event time} = k\} + \sum_{k \neq -1} \theta_k * (\text{HighAg}_r * 1\{\text{event time} = k\}) + \alpha_t + \gamma_{r,a,e,q(t)} + \varepsilon_{rtgae}$$

The coefficients θ_k trace the additional change in hours in more agriculture dependent regions relative to less agriculture dependent regions around drought onsets (HighAg minus LowAg).

P2 findings

Table 3 show clear spillovers beyond agriculture. In more agriculture-dependent regions, severe drought onsets are followed by reductions in non-agricultural hours. The pattern is more persistent in services than in manufacturing.

Table 3: Manufacturing and services spillovers

	Manufacturing		Services	
Event time (quarters)	**Men**	**Women**	**Men**	**Women**
t=-5	-0.122	-1.229	-0.086	-0.589
	(0.640)	(1.422)	(0.846)	(0.499)
t=-4	-0.392	-0.909	0.579	-0.060
	(0.477)	(0.618)	(0.909)	(0.698)
t=-3	-0.054	-0.505	-0.896	0.164
	(0.828)	(1.345)	(0.605)	(0.591)

t=-2	-1.544**	0.231	0.100	0.079
	(0.749)	(1.095)	(0.595)	(0.880)
t=-1 (base)	0.000	0.000	0.000	0.000
t=0	-3.124	-0.250	-5.435*	-2.348
	(2.585)	(4.184)	(3.240)	(1.605)
t=1	-2.812	4.225	-0.171	1.595*
	(2.134)	(2.835)	(1.000)	(0.909)
t=2	0.855	-0.567	-0.275	-2.068**
	(1.197)	(2.020)	(1.637)	(0.884)
t=3	-2.130	-4.357***	-2.099*	-1.438
	(1.885)	(1.113)	(1.262)	(1.284)
t=4	-2.069*	-5.488***	-3.213***	-2.129
	(1.250)	(1.301)	(1.106)	(1.344)
t=5	-2.632**	1.334	-2.412***	-1.247
	(1.064)	(1.165)	(0.722)	(1.142)
t=6	-3.722**	-0.062	-1.909	-2.688***
	(1.623)	(0.841)	(1.245)	(0.904)
t=7	-0.856	-6.369**	-3.615***	-2.202***
	(0.698)	(2.852)	(1.197)	(0.824)
t=8	-2.193***	0.945	-4.809***	-2.919***
	(0.839)	(2.098)	(1.039)	(0.817)
t=9	-1.031*	-1.100	-2.625***	-2.872***
	(0.622)	(1.006)	(0.620)	(0.483)
t=10	-2.308*	-0.330	-2.532**	-2.534***
	(1.246)	(1.377)	(0.984)	(0.723)

Notes: Coefficients with significance stars (* p<0.10, ** p<0.05, *** p<0.01). Cluster-robust SE in parentheses. Base period t=-1 normalized to 0. Observations for manufacturing (cells): Men=5760, Women=5714. Observations for services (cells): Men=5760, Women=5760.

Figure 4 shows that the manufacturing response is concentrated in specific horizons rather than smooth. Hours in high-ag regions fall relative to low-ag regions at medium horizons. The decline appears earlier and larger for women (around three to four quarters after onset, roughly 4-6 fewer hours per week), whereas for men it materializes later (around five to eight quarters after onset, roughly 3 fewer hours).

Figure 4: Manufacturing spillovers

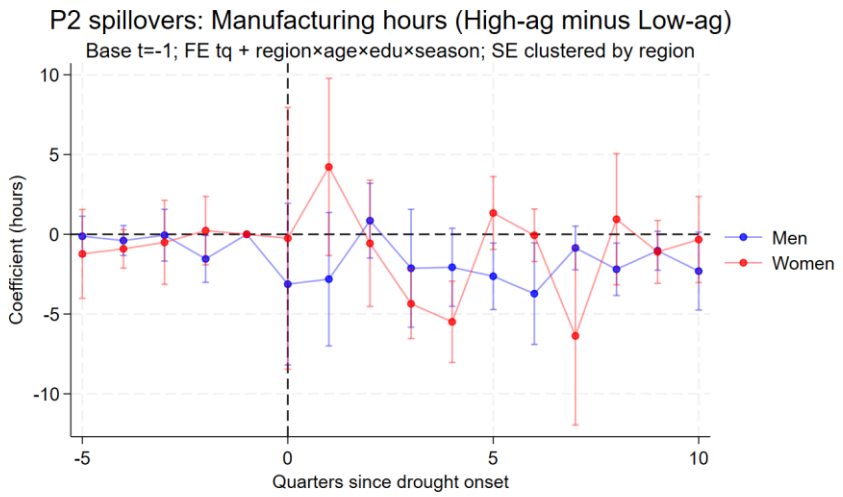
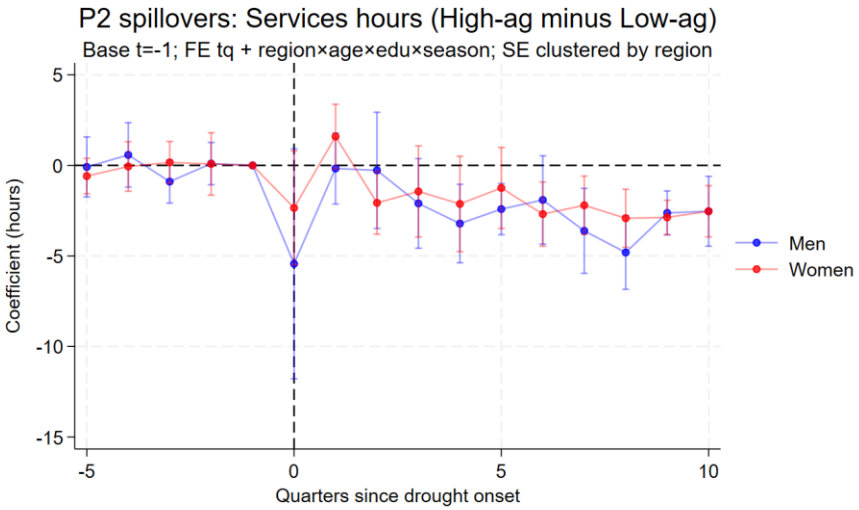


Figure 5 shows that services response is more persistent. For both men and women, hours in high-ag regions decline within the first year after onset and remain below baseline through later horizons. The differential emerges early for both men and women: for men it is already negative at onset, while for women it turns clearly negative within the first year (from about two quarters after onset) and remains below baseline at later horizons. These estimates provide strong evidence that severe drought onsets propagate beyond agriculture through sustained reductions in service-sector hours in more agriculture-dependent regions.

Figure 5: Services spillovers



5.3 P3: Spillover mechanisms within services

P3 decomposes services to probe whether spillovers align with a local demand mechanism, a production linkage mechanism, or stabilization through public and socially provided services. Using the four service branches described in Section 4, I re-estimate the P2 event-study interaction design separately by branch.[2]

P3 findings

Table 4 shows that disaggregating services into broad branches reveals heterogeneous responses. The aggregate decline in services in P2 reflects offsetting movements across branches, and the pattern differs by gender.

Table 4: Services branches

	Branch 1 - Consumer market services		Branch 2 -Transport and communications		Branch 3 - Producer/business services		Branch 4 - Public/social services	
Event time (quarters)	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
t=-5	-2.369**	0.797	2.612*	-0.189	1.273	-3.004**	0.319	0.420
	(1.016)	(0.647)	(1.561)	(2.433)	(2.029)	(1.433)	(0.702)	(0.843)
t=-4	2.315***	-0.181	0.803	-5.499	0.128	-6.719***	0.880	-0.940
	(0.814)	(1.378)	(1.051)	(6.341)	(2.100)	(2.221)	(1.571)	(0.992)
t=-3	-0.557	-0.869	-3.948***	3.865	-3.262*	0.107	-0.930	0.026
	(0.948)	(1.535)	(1.469)	(2.758)	(1.752)	(1.550)	(1.087)	(0.780)
t=-2	-1.163	2.223*	-5.118**	6.435**	0.360	-2.578	0.293	0.324
	(2.908)	(1.344)	(2.161)	(2.834)	(2.447)	(2.037)	(0.688)	(0.490)
t=-1 (base)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t=0	1.486	-2.362*	-1.166	-10.284**	-7.727**	4.779	2.090	1.029
	(1.345)	(1.360)	(1.774)	(4.329)	(3.466)	(4.990)	(2.265)	(0.763)
t=1	1.581*	0.006	-3.903**	-9.727***	-0.261	1.493	2.296	0.891
	(0.921)	(1.127)	(1.759)	(2.825)	(2.049)	(2.674)	(1.474)	(0.823)
t=2	-0.338	2.759	0.554	4.275	2.640**	5.213**	-0.721	1.606*
	(1.726)	(1.715)	(1.714)	(3.481)	(1.157)	(2.527)	(0.636)	(0.964)
t=3	0.017	2.048	3.802	-1.458	6.331*	3.941*	3.660**	-0.496
	(1.590)	(1.838)	(4.402)	(2.613)	(3.719)	(2.060)	(1.672)	(0.901)
t=4	5.437*	-2.039	5.333	-3.753	-2.098	6.193**	1.727	1.902***
	(2.992)	(1.733)	(3.864)	(4.420)	(3.522)	(3.145)	(1.225)	(0.629)
t=5	-0.054	1.834	-0.205	0.030	4.098***	-3.036	-0.450	0.441
	(1.139)	(2.568)	(1.340)	(4.966)	(0.800)	(4.532)	(1.429)	(0.912)
t=6	-1.459	4.335***	-0.952	13.140***	10.072***	-3.006	0.123	-1.316
	(1.056)	(1.193)	(2.355)	(3.294)	(3.199)	(3.941)	(2.408)	(1.293)
t=7	-2.029**	0.203	0.566	0.596	0.550	-1.692	0.929	-0.456
	(0.827)	(1.234)	(1.250)	(3.471)	(2.872)	(3.093)	(0.888)	(0.979)
t=8	7.144***	-2.113***	7.831***	8.116***	-1.096	15.321***	0.354	3.386***
	(0.557)	(0.661)	(0.864)	(2.227)	(1.482)	(1.276)	(0.712)	(0.269)
t=9	5.385***	-2.049*	-6.059***	-10.587***	4.677***	0.111	4.362***	4.253***

[2] This analysis cannot be conducted for manufacturing because branch-level disaggregation is not available in the ENE dataset.

	(0.626)	(1.185)	(0.623)	(2.530)	(0.872)	(2.126)	(0.975)	(0.215)
t=10	5.050***	-1.889***	-12.015***	-3.440**	3.566***	0.017	4.664***	5.076***
	(0.566)	(0.702)	(0.714)	(1.401)	(1.254)	(1.400)	(0.485)	(0.144)

Notes: Coefficients with significance stars (* p<0.10, ** p<0.05, *** p<0.01). Cluster-robust SE in parentheses. Base period t=-1 normalized to 0. Observations for branch 1 (cells): Men=2688, Women=2688. Observations for branch 2 (cells): Men=2652, Women=2383. Observations for branch 3 (cells): Men=2655, Women=2622. Observations for branch 4 (cells): Men=2688, Women=2688.

Figure 6 shows that consumer market services (trade and hospitality) display the clearest gender divergence at longer horizons. Men's hours in high-ag regions recover and even rise relative to low-ag regions in the late post-onset period, while women's hours remain lower at key horizons. This suggests within-services reallocation across gender-segmented jobs rather than a uniform contraction.

Figure 6: Services branch 1

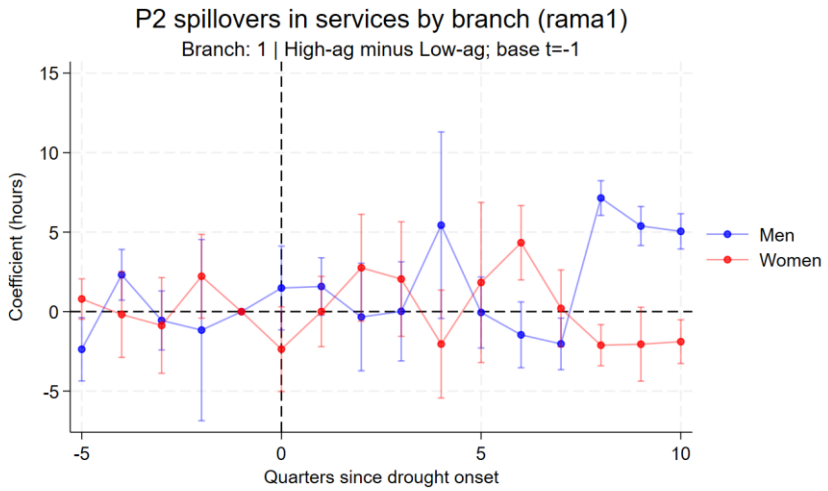


Figure 7 shows that transport and communications have less stable dynamics. Estimates fluctuate across quarters and confidence intervals widen, consistent with episodic adjustment and smaller branch level samples.

Figure 7: Services branch 2

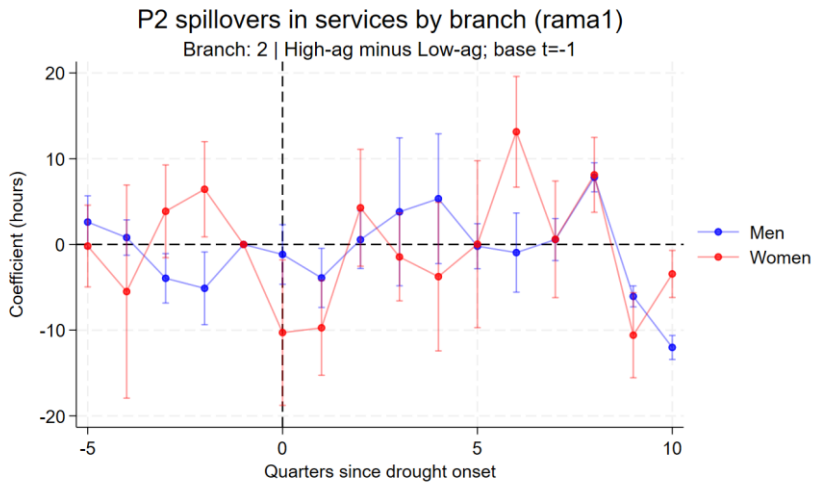


Figure 8 and 9 shows that producer/business services and public/social services respectively, exhibit more evidence of medium to late horizon increases in high-ag regions. The public and social branch shows the most coherent pattern, with positive differentials for both men and women at longer horizons. One interpretation is partial stabilization through institutionally determined hours and public provision when private local demand weakens.

Figure 8: Services branch 3

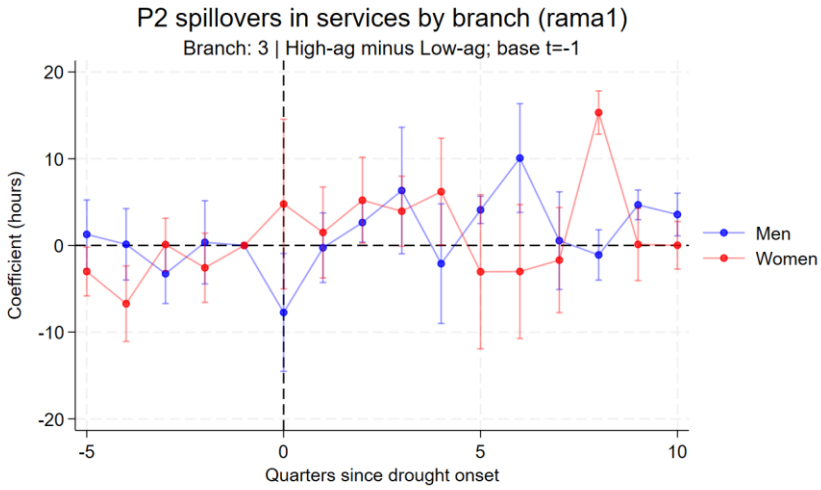
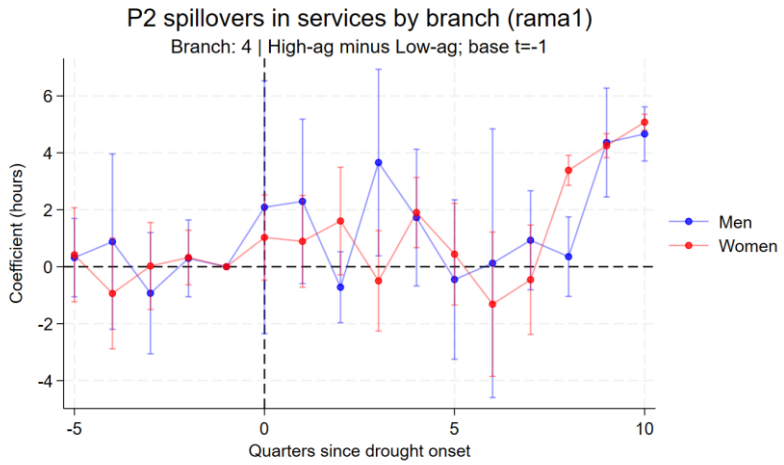


Figure 9: Services branch 4



Two cautions apply. First, inference relies on 16 regional clusters, so individual coefficients should not be over-interpreted. Second, because the outcome is average hours among those employed in a branch, estimates can reflect both within job hour adjustment and selection across employment and branches.

5.4 P4: Migration and spatial adjustment

P4 examines whether internal migration operates as a residual margin of adjustment by gender and whether local economic diversification attenuates drought-related migration. The baseline migration model is a linear probability model with origin-region and year fixed effects:

$$M_{iot} = \beta_1 D_{ot} + \beta_2 Div_{ot} + \beta_3 (D_{ot} \times Div_{ot}) + X_i'\gamma + \mu_o + \lambda_t + \mu_{iot},$$

where M_{iot} equals one if individual i living in year t is observed as a migrant from origin region o (i.e., current region differs from the region five years earlier); $D_{rt}$is drought at the origin region-year, Div_{ot} is origin diversification, and X_i includes age and education controls. The coefficient $\beta_3$is central for P4: it captures whether diversification attenuates the association between drought and migration, which is the residual-margin mechanism. I also estimate (i) a wage-buffering regression among employed stayers (log labour income on out-migration rates) and (ii) a destination absorption regression comparing migrants and non-migrants within destination region-years.

P4 findings

Table 5 confirms that inter-regional migration is uncommon (around 2-4 percent), consistent with spatial mobility being a residual margin of adjustment. It shows that drought exposure at the origin is nonetheless associated with higher out-migration (about a 2-percentage point increase). This relationship is weaker in more diversified origins: the drought by diversification interaction is negative, implying that local diversification dampens mobility induced by droughts.

I find limited evidence that the drought-diversification margin differs by gender. Point estimates are similar for men and women, consistent with mobility reflecting household relocation and longer-distance moves rather than exclusively male labour migration.

Table 5: Migration (5y): drought × diversification

Regressor	(1) Baseline	(2) + interactions by gender
Origin drought (SPEI3<=-1)	0.021**	0.022**
	(0.007)	(0.008)
Diversification at origin (1-HHI)	0.138***	0.147***
	(0.041)	(0.041)
Drought × diversification (origin)	-0.035**	-0.037*
	(0.015)	(0.019)
Female	-0.001	0.007*
	(0.001)	(0.003)
Female × drought		-0.003
		(0.008)
Female × diversification		-0.018*
		(0.009)
Female × drought × diversification		0.004
		(0.019)

Notes: Clustered SE (origin region) in parentheses. Controls: age (quadratic) + education dummies. FE: origin region + year. Obs.: (1)=347781, (2)=347781. R-sq: (1)= 0.012, (2)= 0.012.

Table 6 shows that out-migration also does not generate wage gains for women who stay behind. In the wage-buffering regression, the out-migration slope is not more favourable for women; in fact, women's labour income moves worse relative to men's within origins over time.

Table 6: Wage buffering (stayers): out-migration and income

Regressor	(1) Overall out-migration	(2) Male out-migration
Out-migration rate (origin region-year)	0.179	0.578
	(0.535)	(0.460)
Female	-0.306***	-0.309***
	(0.034)	(0.034)
Out-migration rate × Female	-1.402**	-1.284*
	(0.653)	(0.616)

Notes: Clustered SE (origin region) in parentheses. Controls: age (quadratic) + education dummies. FE: origin region + year. Sample: employed stayers (region_origin=region_dest). Obs.: (1)=151916, (2)=151916. R-sq: (1)= 0.298, (2)= 0.298.

Finally, Table 7 shows that migrants are predominantly absorbed outside agriculture. Conditional on destination region-year fixed effects, migrants are more likely than non-migrants in the same destination to work in non-agricultural sectors, with little systematic gender heterogeneity. This supports interpreting migration as a diversification margin rather than a mechanism that stabilizes local agricultural labour demand.

Table 7: Destination absorption into non-ag jobs

Regressor	(1) All employed	(2) Migrants only
Migrant (across regions, 5y)	0.014**	
	(0.006)	
Female	0.042**	0.037***
	(0.014)	(0.009)
Migrant × Female	-0.005	
	(0.008)	
Origin drought (SPEI3<=-1)		0.006
		(0.010)
Destination diversification (1-HHI)		-0.129
		(0.378)

Notes: Clustered SE in parentheses. (1) FE: destination region + year; cluster = destination region. (2) FE: destination region + year; cluster = destination region; sample = employed migrants only. Obs.: (1)=170764, (2)=6905. R-sq: (1)= 0.128, (2)= 0.087.

5.5 Robustness checks

This section reports robustness exercises that probe three concerns: (i) sensitivity to the dating and definition of drought onset, (ii) inference with a small number of regional clusters, and (iii) measurement choices in the migration analysis. Appendix A reports the corresponding estimates and diagnostics.

First, I re-estimate the P1-P3 event studies under alternative onset rules (Appendix A.1-A.2). A minimum gap definition (GAP8) that requires eight quarters between consecutive onsets reduces overlap across event windows and improves pre-trend diagnostics. Under GAP8, the qualitative patterns are broadly similar: men's limited term contracting increases at medium horizons, and service sector hours decline persistently in more agriculture dependent regions. For women, the block averages do not show an average decline in agricultural employment share in the first 0-2 quarters, but they do show a decline at longer horizons (7-10 quarters). Effect sizes are similar to the baselines results, although precision falls mechanically as fewer events remain usable.

I also consider stricter definitions based on an extreme threshold SPEI-3 <= -2 (TAU2) and a persistence rule that requires the severe threshold to hold for at least two consecutive quarters (PERSIST2). These variants tend to select later stages of drought episodes, so some adjustment can appear in the pre-window. Even so, post-onset patterns continue to point to limited intensive-margin adjustment within agriculture and to economically meaningful spillovers in services, consistent with the baseline interpretation.

Second, to reduce reliance on individual event-time coefficients in a setting with 16 clusters, I summarise dynamics into block averages over 0–2, 3–6, and 7–10 quarters after onset (and, for outcomes only available over shorter windows, 0–2 and 3–4), and report joint Wald tests for each block (Appendix A.1–A.2). The block summaries sharpen the timing highlighted before: women's agricultural employment share declines are more pronounced at longer horizons (7–10 quarters), men's limited term contracting rises at medium horizons (3–4 quarters), and service-sector

spillovers are negative at medium horizons (3–6 quarters) and larger in the 7–10 quarter block. Where feasible, I complement clustered inference with wild-cluster bootstrap p-values at the block level, and conclusions are similar.

Finally, I examine robustness of P4 to alternative drought measures and migration and income constructions (Appendix Tables A.3). I use multi-year drought frequency measures, and it yields similar results: drought is associated with higher out-migration primarily from less diversified origins, and migrants are absorbed mainly outside agriculture. Alternative out-migration constructions (including leave-one-out rates) and income do not overturn the qualitative conclusion that higher out-migration does not translate into earnings gains for women who remain in origin regions.

6. Mechanisms

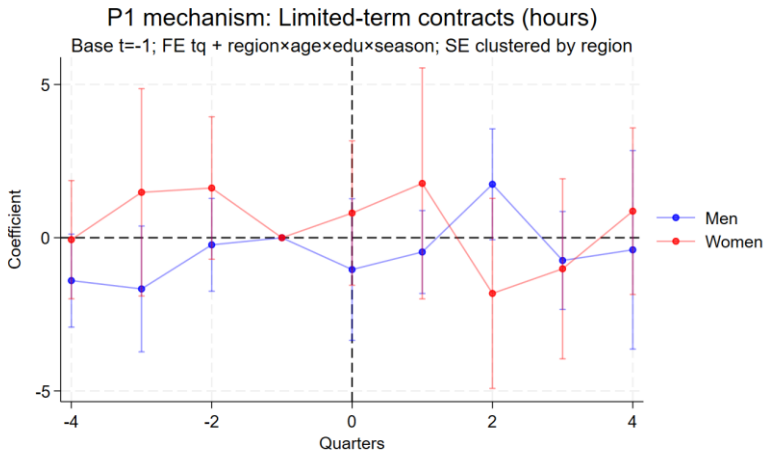
Section 5 documents four empirical patterns that speak to the margins through which drought affects local labour markets. This section links these patterns to the theoretical framework. It aims to interpret the timing and heterogeneity as evidence on plausible adjustment mechanisms.

6.1 Why agricultural hours adjust little on impact

Table 1 shows that on impact, average hours in agriculture remain close to zero for both men and women. In contrast, women's agricultural employment share drops sharply at onset, about 1 percentage point; while men's agricultural employment share declines with a delay, peaking around one year after onset at about 0.8 percentage points. These two facts imply that a stable intensive margin does not mean that agricultural labour input is unaffected; labour supplied to agriculture can fall through reallocation out of the sector even if hours conditional on employment change little.

The discrepancy between hours and employment shares is consistent with a selection mechanism. Figures 10 shows that drought appears to push marginal and more seasonal agricultural jobs out of the sector, especially among women, which mechanically stabilises average hours among the remaining employed. This interpretation is reinforced by the blocked summaries in Appendix A.1: the average change in women's agricultural employment share over the first three post-onset quarters is small and statistically indistinguishable from zero (Post 0–2), while the decline is larger at longer horizons (Post 7-10).

Figure 10: P1 mechanism – Limited term contracts Hours

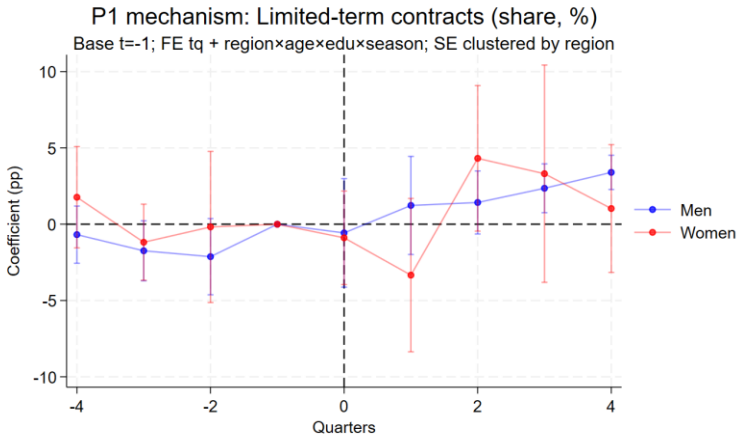


Institutional and measurement factors may also dampen observed intensive adjustment. ENE hours are reported for a short reference week and may not capture within week rationing (shorter days, lower intensity, downtime) or shifts toward unpaid work. At longer horizons, women's agricultural hours are around 1–2 hours lower on average (e.g., Table 1 implies about 1.2 fewer hours over t=7–10), consistent with underemployment among those who remain employed and with gradual adjustment as drought persists.

6.2 Job quality as an adjustment margin

Participation adjustments are important, but drought also reshapes job quality within agriculture. Figure 11 shows that the most robust compositional response is a rise in the share of dependent male agricultural workers on limited-term contracts. Appendix A.1 shows an increase of roughly three percentage points in the 3-4 quarters after onset (Post 3-4).

Figure 11: P1 mechanism - Limited term contracts Share



This timing matches the delayed decline in men's agricultural employment share and suggests that firms absorb drought risk by relying more on flexible contracts and by not renewing existing matches. In a setting with strong seasonality and contract segmentation, fixed-term hiring can substitute for wage and hour adjustments.

The welfare implications are non-trivial. Limited-term jobs typically provide weaker employment protection and less predictable income streams, so drought may increase vulnerability even when posted wages do not fall sharply. For women, contract composition estimates are less precise under the baseline onset definition, consistent with adjustment operating primarily through exit rather than within sector contract substitution.

6.3 Services spillovers: demand, linkages, and stabilization

The spillover results indicate that drought is not confined to farm labour demand. In more agriculture dependent regions, Figure 5 shows sustained reductions in service sector hours after drought onset. Manufacturing also declines, but the response is more episodic and concentrated at medium horizons.

The relative persistence of services is consistent with a local demand channel. A fall in agricultural income and heightened uncertainty reduce spending on non-tradable services, which are locally produced and consumed. Manufacturing responses are smaller and less smooth: women's manufacturing hours fall by roughly 4-6 hours per week about three to four quarters after onset, while men's hours decline later by around 3 hours at five to eight quarters after onset (Figure 4). This pattern is consistent with weaker local linkages and with tradable activities that can partially reorient to outside demand.

Table 4 strengthens this interpretation by showing heterogeneity within services. Consumer market services (trade and hospitality) remain weak for women at longer horizons, while men's hours recover and eventually rise in the late post-onset period. This pattern suggests within sector reallocation across gender segmented jobs rather than a uniform contraction.

Public and social services display the most coherent positive differentials at longer horizons. One reading is partial stabilisation through institutionally determined staffing and public provision when private demand weakens. Because outcomes are average hours among those employed in each branch, these estimates can reflect both within job hour changes and selection into and out of employment.

6.4 Migration as a residual margin

The migration results are consistent with mobility acting as a residual margin of adjustment. Inter-regional migration rates are low in levels, but Table 5 indicates that drought exposure at the origin is associated with a meaningful increase in out-migration (about 2 percentage points).

Importantly, the drought–migration relationship is weaker in more diversified labour markets. The negative drought by diversification interaction implies that local opportunity sets substitute for

geographic mobility: when employment is more evenly distributed across sectors, workers can reallocate locally rather than leave the region.

Migration does not, however, appear to stabilise earnings for women who remain in origin regions. The wage buffering estimates in Table 6 are not more favourable for women; in fact, women's labour income moves worse relative to men's as out-migration rises. This is consistent with gendered segmentation and with local downturns that depress service jobs where women are concentrated, rather than with a tight labour market created by the exit of workers.

Finally, Table 7 shows that migrants are absorbed predominantly outside agriculture within destination regions. This supports viewing migration as a diversification response, complementing sectoral reallocation and job quality adjustment rather than directly stabilising agricultural labour demand.

Overall, the evidence points to a combination of selection and job quality changes within agriculture, demand driven spillovers to local services, and residual migration shaped by diversification. These mechanisms align with the conceptual framework's emphasis on sectoral linkages and gender differentiated constraints.

7. Discussion of results

The results paint a coherent picture of drought adjustment in a diversified upper-middle-income setting. The direct agricultural effects are economically meaningful but modest at quarterly frequency among those who remain employed. The main within agriculture margins are (i) women's short run exit from agricultural employment at onset and (ii) men's deterioration in job stability through limited term contracting at medium horizons. These margins are consistent with gender segmentation in seasonal agro-industry work and with asymmetric mobility and outside options.

A central implication is that indirect effects can dominate direct intensive-margin responses. In regions more dependent on agriculture, services hours decline persistently following drought onset, and manufacturing hours fall at selected medium horizons. These spillovers are consistent with local general-equilibrium propagation through farm income, demand for non-tradables, and production linkages. The branch decomposition further shows that spillovers are shaped by local service composition and by the capacity of public and social services to stabilise labour demand.

The migration results refine common narratives about mobility induce by climate shocks. Drought is associated with higher inter-regional migration, but the relationship depends on local economic structure: diversification attenuates drought linked migration. At the regional level, migration is not strongly predominantly male, and higher out-migration is not associated with earnings gains for women who remain. This suggests that distributional consequences of drought can persist even when migration occurs, and that the relevant mechanisms may operate at smaller spatial scales or through job quality and participation channels.

There are three policy implications from these findings. First, drought response and adaptation policies that focus only on agricultural production may miss important spillovers to services and to gendered employment outcomes. Second, protecting women's attachment to paid work during climatic stress may require targeted instruments beyond farm support, including childcare and transport infrastructure that relax time and mobility constraints, and active labour market policies that facilitate transitions into stable non-farm jobs. Third, strengthening social protection and local public service capacity can help stabilise demand and reduce the need for distress driven migration in less diversified regions.

However, two limitations should guide interpretation. The ENE is representative at the regional level, so the analysis cannot identify municipality level heterogeneity or short-range mobility with high precision. Inference relies on 16 clusters, which motivates emphasis on effect profiles, blocked estimates, and robustness to conservative event definitions. Earnings evidence from ESI is informative but limited by annual measurement. These limitations also suggest clear directions for future work, including linking administrative data on water allocation and agricultural production to finer spatial labour market outcomes.

8. Conclusion

This paper estimates the gendered labour market effects of severe drought onsets in Chile during 2010-2024. I use multi-event event-study designs and complementary migration and income analyses in order to provide joint evidence on direct agricultural adjustment, spillovers beyond agriculture, and spatial reallocation.

Three conclusions emerge. First, within agriculture, average hours among continuing workers adjust little at drought onset, but women's agricultural employment share falls on impact and men's job stability deteriorates at medium horizons. Second, drought propagates to the broader regional economy: services (and to a lesser extent manufacturing) exhibit persistent reductions in hours in agriculture dependent regions. Third, service spillovers are heterogeneous, and public and social services appear to partially stabilise local labour input. Migration operates as a residual margin: drought is associated with higher inter-regional migration mainly in less diversified origins, and migrants are absorbed into non-agricultural work, but higher out-migration does not translate into earnings gains for women who remain.

Taken together, the findings suggest that in diversified labour markets, climate shocks can widen gender gaps through participation and job quality margins and through indirect spillovers. Policies that build climate resilience should therefore consider labour market structure, gendered constraints, and cross-sector linkages alongside agricultural adaptation.

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Appendix

Appendix A. Robustness to alternative drought definitions and blocked event-study inference.

Appendix A.1

It reports robustness results for P1 using (i) alternative definitions of drought onset and (ii) blocked summaries of the event-study dynamics. All specifications replicate the baseline identification strategy, absorbing region by demographic, by season fixed effects and common time shocks and

cluster standard errors at the regional level (16 regions). Outcomes are aggregated to region-quarter-gender-age group-education group cells.

The event study is estimated over an 8-quarter pre-period and a 10-quarter post-period, and the dynamic coefficients are summarized into post-onset blocks of 0–2, 3–6, and 7–10 quarters after onset (and, for outcomes only available over shorter windows, 0–2 and 3–4, with later blocks reported as n/a). For each outcome and gender, Table A.1 reports (a) the block-average estimate (a linear combination of event-time coefficients), (b) its clustered standard error and p-value, and (c) a Wald test for the joint significance of the event-time coefficients within that block. The table also reports a joint test of all pre-event coefficients.

Table 8: Extensive margin - Agriculture employment share among employed

Specification / Block	**Men**	**Women**
BASE (tau=-1.5, gap=0) - Pre-trends p (Wald)	p=0.027	p=0.244
Pre-trends p (Wild)		
Post 0-2	0.383	0.796
	(0.567)	(1.163)
Post 3-6	-0.417	-0.668
	(0.574)	(0.721)
Post 7-10	0.429	-1.457***
	(0.507)	(0.309)
GAP8 (min gap=8q) - Pre-trends p (Wald)	p=0.175	p=0.541
Pre-trends p (Wild)		
Post 0-2	0.353	0.509
	(0.540)	(1.091)
Post 3-6	-0.587	-0.589
	(0.493)	(0.831)
Post 7-10	0.238	-1.310**
	(0.532)	(0.450)
TAU2 (tau=-2.0) - Pre-trends p (Wald)	p=0.000	p=0.001
Pre-trends p (Wild)		
Post 0-2	-3.455	-1.937*
	(3.679)	(1.083)
Post 3-6	-3.505**	4.817**
	(1.592)	(1.930)
Post 7-10	-0.169	0.824
	(0.421)	(0.658)
PERSIST2 (requires drought persists 2q) - Pre-trends p (Wald)	p=0.171	p=0.000
Pre-trends p (Wild)		
Post 0-2	-0.324	-3.357***
	(1.005)	(0.948)
Post 3-6	-1.301*	-1.064
	(0.715)	(2.519)
Post 7-10	0.382	-2.458***
	(0.430)	(0.652)

Notes: Post-block stars use p_lin of block mean. Pre-trends are p-values. Obs. ranges across specs: Men=5760–5760, Women=5760–5760. Clusters ranges: Men=16–16, Women=16–16.

Table 9: Mechanism A: Limited-term contracts (share, pp)

Specification / Block	Men	Women
BASE (tau=-1.5, gap=0) - Pre-trends p (Wald)	p=0.370	p=0.415
Pre-trends p (Wild)		
Post 0-2	0.695	0.030
	(1.036)	(1.800)
Post 3-4	2.877***	2.169
	(0.531)	(2.507)
Post 7-10 (n/a)		
GAP8 (min gap=8q) - Pre-trends p (Wald)	p=0.389	p=0.733
Pre-trends p (Wild)		
Post 0-2	0.647	-0.686
	(1.106)	(1.979)
Post 3-4	1.910**	1.048
	(0.806)	(2.925)
Post 7-10 (n/a)		
TAU2 (tau=-2.0) - Pre-trends p (Wald)	p=0.001	p=0.011
Pre-trends p (Wild)		
Post 0-2	2.230	9.318**
	(4.034)	(3.242)
Post 3-4	1.128	-2.087
	(4.687)	(5.519)
Post 7-10 (n/a)		
PERSIST2 (requires drought persists 2q) - Pre-trends p (Wald)	p=0.731	p=0.000
Pre-trends p (Wild)		
Post 0-2	0.698	-0.234
	(2.902)	(3.661)
Post 3-4	-0.486	7.281
	(0.836)	(6.003)
Post 7-10 (n/a)		

Notes: Post-block stars use p_lin of block mean. Pre-trends are p-values. Obs. ranges across specs: Men=5112–5112, Women=4256–4256. Clusters ranges: Men=16–16, Women=16–16.

Table 10: Mechanism B: Hours among limited-term workers

Specification / Block	Men	Women
BASE (tau=-1.5, gap=0) - Pre-trends p (Wald)	p=0.264	p=0.565
Pre-trends p (Wild)		
Post 0-2	0.080	0.253
	(0.359)	(0.937)
Post 3-4	-0.568	-0.073
	(0.928)	(1.262)
Post 7-10 (n/a)		
GAP8 (min gap=8q) - Pre-trends p (Wald)	p=0.482	p=0.125
Pre-trends p (Wild)		
Post 0-2	0.011	-0.143
	(0.548)	(0.879)
Post 3-4	-0.793	-0.328
	(1.068)	(1.444)
Post 7-10 (n/a)		

TAU2 (tau=-2.0) - Pre-trends p (Wald)	p=0.000	p=0.025
Pre-trends p (Wild)		
Post 0-2	1.886	-0.404
	(4.608)	(1.379)
Post 3-4	7.249	0.803
	(4.947)	(1.454)
Post 7-10 (n/a)		
PERSIST2 (requires drought persists 2q) - Pre-trends p (Wald)	p=0.014	p=0.097
Pre-trends p (Wild)		
Post 0-2	-0.846	-3.229***
	(1.001)	(0.857)
Post 3-4	1.293	-0.403
	(1.249)	(1.421)
Post 7-10 (n/a)		

Notes: Post-block stars use p_lin of block mean. Pre-trends are p-values. Obs. ranges across specs: Men=3865–3865, Women=3202–3202. Clusters ranges: Men=16–16, Women=15–15.

Appendix A.2

It provides analogous blocked estimates and pre-trend diagnostics for P2 spillovers (manufacturing and services) and for the P3 branch decomposition, including wild-cluster bootstrap p-values where feasible.

Table 11: P2 Manufacturing

	GAP8		PERSIST2		TAU2	
Event time (quarters)	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
t=-5	-0.392	-0.116	0.200	1.919	0.013	-3.044*
	(0.587)	(0.947)	(1.741)	(3.391)	(1.938)	(1.722)
t=-4	-0.201	-0.605	1.525	0.341	-3.507	4.152***
	(0.574)	(0.825)	(1.967)	(0.985)	(2.750)	(1.009)
t=-3	0.014	0.070	1.315	1.449	-1.067	-0.413
	(1.000)	(1.391)	(2.189)	(1.862)	(2.397)	(1.036)
t=-2	-1.626*	0.595	0.359	-2.235	-2.081***	-2.083
	(0.877)	(1.164)	(1.790)	(2.494)	(0.745)	(1.538)
t=-1 (base)	0.000	0.000	0.000	0.000	0.000	0.000
t=0	-3.910	0.185	-0.422	0.969	0.438	-2.929
	(2.969)	(4.676)	(0.882)	(1.707)	(0.929)	(3.506)
t=1	-3.508	4.408	1.945	1.025	2.825***	5.424**
	(2.382)	(3.092)	(1.228)	(1.677)	(0.908)	(2.536)
t=2	0.996	0.668	1.291	2.389	1.956***	1.967
	(1.358)	(2.279)	(0.880)	(2.431)	(0.726)	(1.537)
t=3	-1.990	-4.273***	-0.317	-3.258	2.525	-4.009**
	(2.269)	(1.184)	(2.528)	(2.041)	(1.897)	(1.841)
t=4	-2.957**	-5.450***	1.530	0.442	-3.897***	1.992
	(1.322)	(1.403)	(1.421)	(1.268)	(1.308)	(1.382)
t=5	-2.974***	1.578	-0.465	3.966	-2.072**	-1.228
	(1.152)	(1.203)	(1.771)	(2.736)	(0.884)	(1.278)
t=6	-4.439**	0.045				
	(1.955)	(1.169)				

t=7	-1.062	-6.757**				
	(0.922)	(2.903)				
t=8	-2.366***	0.429				
	(0.727)	(2.363)				
t=9	-1.335	-2.131*				
	(0.824)	(1.092)				
t=10	-2.758*	-1.364				
	(1.435)	(1.484)				

Notes: GAP8 (tau=-1.50, min gap=8, persist2=0) - Pre-trends p (if in CSV): Men=0.381, Women=0.519. Cells (N): Men=5760, Women=5714. Clusters: Men=16, Women=16. PERSIST2 (tau=-1.50, min gap=0, persist2=1) - Pre-trends p (if in CSV): Men=0.640, Women=0.146. Cells (N): Men=5760, Women=5714. Clusters: Men=16, Women=16. TAU2 (tau=-2.00, min gap=0, persist2=0) - Notes: Pre-trends p (if in CSV): Men=0.000, Women=0.000. Cells (N): Men=5760, Women=5714. Clusters: Men=16, Women=16.

Table 12: P2 Services

	GAP8		PERSIST2		TAU2	
Event time (quarters)	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
t=-5	-0.006	-0.431	5.136***	1.683	4.793***	0.438
	(0.910)	(0.461)	(1.708)	(2.002)	(1.809)	(1.882)
t=-4	0.597	-0.266	3.815**	-0.902	4.089**	1.805**
	(1.054)	(0.628)	(1.712)	(1.106)	(1.590)	(0.864)
t=-3	-1.282**	-0.129	0.566	0.812	-1.351	0.192
	(0.554)	(0.477)	(2.005)	(1.605)	(1.332)	(2.083)
t=-2	-0.140	-0.061	1.507	0.680	2.167*	-0.855
	(0.578)	(0.691)	(1.231)	(2.126)	(1.139)	(1.189)
t=-1 (base)	0.000	0.000	0.000	0.000	0.000	0.000
t=0	-6.357*	-3.009*	1.769	0.630	-0.283	0.104
	(3.452)	(1.728)	(1.812)	(1.898)	(1.870)	(1.416)
t=1	-0.722	1.474	0.070	-0.141	-3.553***	0.825
	(1.032)	(1.011)	(0.920)	(1.353)	(1.234)	(1.126)
t=2	-0.243	-2.031*	-1.529	-0.310	1.584**	3.770***
	(1.934)	(1.152)	(2.042)	(1.068)	(0.803)	(0.737)
t=3	-2.415*	-1.679	2.839***	0.161	5.321***	4.014***
	(1.382)	(1.461)	(0.788)	(0.901)	(0.847)	(0.770)
t=4	-3.849***	-2.554*	2.354	-0.223	4.431***	-3.100**
	(1.021)	(1.359)	(1.869)	(0.902)	(1.038)	(1.263)
t=5	-2.172**	-1.390	4.607**	-1.505	3.601***	0.020
	(0.893)	(1.103)	(1.824)	(1.674)	(0.653)	(0.709)
t=6	-2.681*	-3.080***				
	(1.545)	(1.120)				
t=7	-3.764***	-1.860*				
	(1.384)	(0.988)				
t=8	-5.232***	-3.103***				
	(1.095)	(1.046)				
t=9	-2.979***	-3.128***				
	(0.684)	(0.618)				
t=10	-2.916***	-2.193**				
	(1.095)	(0.904)				

Notes: GAP8 (tau=-1.50, min gap=8, persist2=0) - Pre-trends p (if in CSV): Men=0.156, Women=0.587. Cells (N): Men=5760, Women=5760. Clusters: Men=16, Women=16. PERSIST2 (tau=-1.50, min gap=0, persist2=1) - Pre-trends p (if in CSV): Men=0.000, Women=0.067. Cells (N): Men=5760, Women=5760. Clusters: Men=16, Women=16. TAU2 (tau=-2.00, min gap=0, persist2=0) - Pre-trends p (if in CSV): Men=0.000, Women=0.000. Cells (N): Men=5760, Women=5760. Clusters: Men=16, Women=16.

Table 13: P2 Block averages

	Manufacturing		Services	
Specification / Block	**Men**	**Women**	**Men**	**Women**
BASE (tau=-1.5, gap=0, persist2=0) - Pre-trends p (leads -2..-5)	p=0.383	p=0.614	p=0.426	p=0.558
Post 0-2	-1.694	1.136	-1.961	-0.940
	(1.465)	(2.316)	(1.494)	(0.758)
Post 3-6	-2.638**	-2.143**	-2.408**	-1.875*
	(1.203)	(0.729)	(0.882)	(1.013)
Post 7-10	-1.597**	-1.714*	-3.395***	-2.632***
	(0.688)	(0.954)	(0.726)	(0.588)
GAP8 (tau=-1.5, gap=8, persist2=0) - Pre-trends p (leads -2..-5)	p=0.381	p=0.519	p=0.156	p=0.587
Post 0-2	-2.141	1.754	-2.441	-1.189
	(1.715)	(2.558)	(1.633)	(0.881)
Post 3-6	-3.090**	-2.025**	-2.779**	-2.176*
	(1.417)	(0.778)	(1.015)	(1.103)
Post 7-10	-1.880**	-2.455**	-3.723***	-2.571***
	(0.853)	(1.057)	(0.790)	(0.732)
PERSIST2 (tau=-1.5, gap=0, persist2=1) - Pre-trends p (leads -2..-5)	p=0.640	p=0.146	p=0.000	p=0.067
Post 0-2	0.938	1.461	0.103	0.060
	(0.826)	(1.113)	(1.040)	(1.101)
Post 3-6	0.187	0.287	2.450**	-0.392
	(1.278)	(1.145)	(1.050)	(0.592)
Post 7-10	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
TAU2 (tau=-2.0, gap=0, persist2=0) - Pre-trends p (leads -2..-5)	p=0.000	p=0.000	p=0.000	p=0.000
Post 0-2	1.740**	1.488	-0.751	1.567*
	(0.762)	(1.786)	(0.560)	(0.879)
Post 3-6	-0.861	-0.811	3.338***	0.233
	(0.668)	(0.884)	(0.561)	(0.470)
Post 7-10	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)

Notes: Stars based on p_lin of the block mean (lincom). Pre-trends row reports p_lead (if provided by the CSV).

Table 14: P3 GAP8

	Branch 1 - Commerce & hospitality		Branch 2 - Transport/ communications		Branch 3 - Finance & business/real estate		Branch 4 - Public, education, health & other	
Event time (quarters)	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
t=-5	-2.608*	0.812	1.214	3.362	4.039***	-4.689***	0.683	-0.349
	(1.407)	(0.991)	(2.125)	(3.542)	(1.560)	(1.298)	(0.928)	(0.844)
t=-4	3.743***	2.478	0.626	-6.198	0.177	-8.383***	2.631	-2.869***
	(1.052)	(2.247)	(1.115)	(8.079)	(2.200)	(2.254)	(1.648)	(0.955)
t=-3	0.605	1.324	-5.938***	4.772*	-5.019**	-1.698	-0.720	-1.606**
	(1.158)	(1.918)	(1.151)	(2.899)	(2.006)	(1.845)	(1.289)	(0.711)
t=-2	-2.228	4.583**	-4.480**	6.089	0.420	-3.161	0.856	0.300
	(3.511)	(2.217)	(2.178)	(3.703)	(2.836)	(2.186)	(0.797)	(0.864)
t=-1 (base)	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
t=0	1.954	2.112	-0.352	-7.994**	-7.416*	3.821	3.282	-1.946*
	(1.551)	(2.452)	(2.180)	(3.971)	(3.808)	(5.497)	(2.300)	(1.046)
t=1	1.522	1.363	-3.465	-11.994***	0.714	1.951	0.537	0.285
	(1.882)	(1.840)	(2.313)	(2.090)	(1.431)	(2.096)	(2.060)	(0.997)
t=2	1.344	3.385*	-0.071	2.622	2.303**	1.587	-0.823	1.658**
	(1.826)	(1.757)	(1.354)	(2.531)	(1.106)	(2.750)	(1.005)	(0.779)
t=3	0.438	2.015	0.060	1.580	4.836**	3.375	2.094**	0.227
	(1.107)	(3.516)	(3.166)	(3.233)	(1.979)	(3.060)	(1.049)	(0.571)
t=4	3.441*	1.760	1.443	1.249	-2.034	3.660	3.563***	0.040
	(2.045)	(1.954)	(2.304)	(5.981)	(3.072)	(3.664)	(0.676)	(0.874)
t=5	1.391	1.768	-0.731	-3.439	2.648	-1.452	0.112	1.074
	(1.090)	(3.025)	(1.308)	(7.081)	(2.015)	(3.818)	(2.222)	(0.786)
t=6	-3.355***	3.341***	-2.231*	3.456**	4.412**	0.329	3.397***	0.258
	(0.862)	(0.951)	(1.230)	(1.591)	(1.718)	(7.551)	(0.872)	(0.200)
t=7	-1.738**	1.062	-2.317*	-3.409	1.421	-1.014	2.730***	-0.177
	(0.692)	(2.070)	(1.385)	(2.661)	(1.957)	(1.413)	(0.389)	(0.324)
t=8	6.905***	1.398	6.871***	10.233***	-0.697	14.115***	1.810**	0.398
	(0.670)	(1.132)	(0.900)	(2.726)	(1.394)	(1.384)	(0.721)	(0.434)
t=9	5.927***	-2.475	-6.390***	-11.033***	4.495***	-0.294	4.698***	2.062***
	(0.864)	(1.724)	(0.974)	(3.612)	(1.164)	(2.189)	(1.290)	(0.416)
t=10	3.053***	-1.256	-12.693***	-5.373***	2.084*	-0.969	6.435***	3.090***
	(0.687)	(1.147)	(0.813)	(1.053)	(1.112)	(2.038)	(0.738)	(0.359)

Notes: Branch 1 - Base period t=-1 normalized to 0. Pre-trends p (leads -2..-5): Men=0.018, Women=0.126. Cells (N): Men=2687, Women=2686. Branch 2 - Base period t=-1 normalized to 0. Pre-trends p (leads -2..-5): Men=0.000, Women=0.000. Cells (N): Men=2652, Women=2383. Branch 3 - Base period t=-1 normalized to 0. Pre-trends p (leads -2..-5): Men=0.004, Women=0.001. Cells (N): Men=2655, Women=2622. Branch 4 - Base period t=-1 normalized to 0. Pre-trends p (leads -2..-5): Men=0.112, Women=0.000. Cells (N): Men=2688, Women=2688.

Table 15: P3 Block averages by branch

	Branch 1 - Commerce & hospitality		Branch 2 - Transport/ communications		Branch 3 - Finance & business/real estate		Branch 4 - Public, education, health & other	
Specification / Block	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**	**Men**	**Women**
BASE (tau=-1.5, gap=0, persist2=0) - Pre-trends p (leads -2..-5)	p=0.008	p=0.393	p=0.000	p=0.001	p=0.051	p=0.028	p=0.020	p=0.000
Post 0-2	1.591	1.374	-1.505	-5.246*	-1.783	3.828	0.628	0.292
	(1.095)	(1.297)	(1.214)	(2.522)	(1.197)	(2.548)	(1.370)	(0.677)
Post 3-6	0.389	1.023	1.995	1.990	4.601**	1.023	1.606	1.035
	(1.443)	(1.240)	(1.327)	(2.108)	(1.905)	(3.054)	(0.924)	(0.863)
Post 7-10	2.777***	-1.250	-2.419***	-1.329	1.924*	3.439**	3.365***	1.671***
	(0.275)	(0.958)	(0.450)	(1.651)	(0.953)	(1.344)	(0.200)	(0.216)
GAP8 (tau=-1.5, gap=8, persist2=0) - Pre-trends p (leads -2..-5)	p=0.018	p=0.126	p=0.000	p=0.000	p=0.004	p=0.001	p=0.112	p=0.000
Post 0-2	1.606	2.286	-1.296	-5.789**	-1.466	2.453	0.999	-0.001
	(1.409)	(1.601)	(1.593)	(2.293)	(1.275)	(2.270)	(1.611)	(0.690)
Post 3-6	0.479	2.221	-0.365	0.712	2.466	1.478	2.291**	0.400
	(1.002)	(2.182)	(1.265)	(3.636)	(1.656)	(4.413)	(0.982)	(0.556)
Post 7-10	3.537***	-0.318	-3.632***	-2.396*	1.826*	2.959*	3.918***	1.343***
	(0.593)	(1.417)	(0.831)	(1.182)	(0.867)	(1.650)	(0.680)	(0.334)

Notes: Pre-trends row reports p_lead (test of leads -2..-5). Post-block stars use the stored p-value from lincom.

Appendix A.3

It reports P4 robustness variants, including multi-year drought measures, alternative constructions of out-migration rates, and income winsorisation.

Table 16: P4 – Migration robustness (drought definition)

Regressor	**(1) Baseline**	**(2) Continuous dryness**	**(3) Threshold - 0.5**	**(4) Threshold - 1.5**
Origin drought / dryness	0.021**	0.008**	0.020**	-0.014
	(0.007)	(0.004)	(0.008)	(0.021)
Origin diversification (1-HHI)	0.138***	0.127**	0.124**	0.119*
	(0.041)	(0.052)	(0.048)	(0.058)
Drought × diversification	-0.035**	-0.012	-0.033	0.040
	(0.015)	(0.009)	(0.020)	(0.045)
Female	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)

Notes: FE = origin region + year. Controls: gender, age (quadratic), education. Obs.: (1)=347781, (2)=347781, (3)=347781, (4)=347781. R-sq: (1)= 0.012, (2)= 0.012, (3)= 0.012, (4)= 0.012.

Table 17: P4 – Migration robustness (timing/exposure measures)

Regressor	(5) Drought avg3	(6) Drought avg5	(7) Drought share5
Origin drought exposure (3y/5y)	-0.084***		0.102***
	(0.008)		(0.024)
Origin diversification (1-HHI)	0.123**	0.129**	0.163**
	(0.057)	(0.056)	(0.060)
Exposure × diversification	0.215***		-0.219***
	(0.015)		(0.048)
Female	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)

Notes: FE = origin region + year. Controls: gender, age (quadratic), education. Obs.: (5)=347781, (6)=347781, (7)=347781. R-sq: (5)= 0.012, (6)= 0.012, (7)= 0.012.

Table 18: P4 – Migration robustness (alternative proxy & sample)

Regressor	(8) Non-ag share proxy	(9) Drop 2020	(10) Drop 2021	(11) Prime age
Origin drought (SPEI<=-1)	-0.038*	-0.007	0.021***	0.025***
	(0.022)	(0.014)	(0.006)	(0.006)
Structure proxy (non-ag share or div)	-0.144	0.217***	0.073	0.158**
	(0.128)	(0.046)	(0.067)	(0.059)
Drought × proxy	0.048*	0.012	-0.028**	-0.043***
	(0.023)	(0.030)	(0.013)	(0.014)
Female	-0.001	-0.001	-0.001	-0.004*
	(0.001)	(0.001)	(0.001)	(0.002)

Notes: FE = origin region + year. Controls: gender, age (quadratic), education. Obs.: (8)=347781, (9)=292387, (10)=270647, (11)=157552.

Table 19: P4 – Wage buffering robustness (regional stayers)

Regressor	(1) Baseline	(2) Leave-one-out	(3) Winsorized income	(4) Prime age	(5) Drop 2020	(6) Drop 2021
Out-migration rate (overall / LOO)	0.179	0.190	0.241	-0.085	0.389	0.120
	(0.535)	(0.535)	(0.498)	(0.611)	(0.668)	(0.663)
Female	-0.306***	-0.306***	-0.287***	-0.277***	-0.310***	-0.312***
	(0.034)	(0.034)	(0.036)	(0.040)	(0.042)	(0.033)
Out-migration × Female	-1.402**	-1.401**	-1.486**	-1.636*	-1.321	-1.257*
	(0.653)	(0.653)	(0.672)	(0.820)	(0.806)	(0.625)

Notes: Sample = employed stayers (origin=dest). FE = origin region + year. Controls: age (quadratic), education. Cluster = origin region.

Table 20: P4 – Wage buffering robustness (male out-migration)

Regressor	(1) Baseline	(2) Leave-one-out
Male out-migration rate (overall / LOO)	0.578	0.589
	(0.460)	(0.460)
Female	-0.309***	-0.309***
	(0.034)	(0.034)
Male out-migration × Female	-1.284*	-1.287*
	(0.616)	(0.616)

Table 21: P4 – Destination absorption robustness (non-ag employment)

Regressor	(1) All employed	(2) Prime age	(3) Dest mig>=50
Migrant (across regions, 5y)	0.014**	0.008	0.015*
	(0.006)	(0.006)	(0.007)
Female	0.042**	0.032**	0.042**
	(0.014)	(0.012)	(0.016)
Migrant × Female	-0.005	0.001	-0.003
	(0.008)	(0.008)	(0.009)

Table 22: P4 – Migrants-only destination sorting robustness

Regressor	(4) Migrants only	(5) Migrants only – prime age
Female	0.037***	0.032***
	(0.009)	(0.008)
Origin drought (SPEI<=-1)	0.006	0.012
	(0.010)	(0.011)
Destination diversification	-0.129	-0.038
	(0.378)	(0.461)