Labor migration and the structure of rural labor markets

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Can labor migration promote a measure of structural change in sending communities by allowing workers to accumulate capital outside of their country of origin? Using the historical experience of massive circular labor migration between Malawi and gold mines in South Africa, we investigate how oscillating flows of labor and inflows of capital affect rural labor markets in the short and long run. Exploiting two plausibly exogenous shocks to the option to migrate, a difference-in-differences design and newly digitized Census and administrative data, we show what happens to labor market outcomes in the wake of these shocks. Employment falls immediately in places with high exposure to migration shocks and workers shift out of subsistence agriculture. In the longer run, labor continues to shift out of agriculture and into services in high migration shock districts, with self-employment \increasing by more than 50%. We isolate capital accumulation as a key channel for these structural changes using archival data on flows of money and men. [161 words]

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Barriers to capital accumulation present one possible reason for the lack of industrialization in sub-Saharan Africa. In most economic growth models, capital accumulation plays an important role in triggering economic growth and structural change in low-income countries. At least in the early stages of structural transformation, savings and access to credit increase, and capital investments in off-farm activities improve worker productivity in the non-agricultural sector. This provides some of the impetus for labor reallocation across sectors and occupations. These forces for labor reallocation are evident both in macroeconomic models that show labor shifting out of agriculture and into off-farm work in the manufacturing and service sectors (e.g. Buera, Kaboski and Shin 2013), and in microeconomic models of occupational change (e.g. Banerjee and Newman 1993). It is therefore not surprising that reducing constraints on savings and on access to capital has been a key area of research in development economics.[2]

In this paper, we ask: Can circular labor migration be an alternative mechanism for triggering a measure of structural change in rural labor markets? Specifically, we examine whether trade in labor and capital across space can lead to labor reallocations across sectors within a rural agrarian setting and whether capital accumulation by migrant workers accounts for these shifts (Foster and Rosenzweig 2004). We study the historical context of rural Malawi and the way in which local labor markets for men and women changed immediately, and two decades after exposure to large, plausibly exogenous shocks to the local supply of male labor through international labor migration.

Conceptually, circular labor migration may affect labor allocation to market work, home production, subsistence farming and self-employment through several channels. Using a simple framework of labor-leisure choice for men and women in a representative household, we show that when men migrate, the marginal productivity of female time in all work activities changes and the shadow value of their time in home production goes up. Females shift time out of market work and into home production and subsistence farming (a substitution effect), unless the loss of household labor is supplemented by inflows of money. In that case, an income effect could depress time in all work activities and reduce overall labor force participation, up to the point where households face a binding minimum subsistence constraint. Importantly, when entry into

[2] The recent expansion of literature on training and cash grants for entrepreneurs in low-income countries is evidence of this continued interest in development economics (e.g. Bandiera et al 2015, Bandiera et al 2013)

self-employment requires an upfront fixed cost, then income from migration can help households defray these fixed costs and lead to a reallocation of labor towards higher value self-employment activities. Moreover, if accumulated capital through miner earnings is invested in small businesses, we should see the concentrated shocks to labor migration having long run effects on the share of men and women working in self-employment.[3]

To investigate these different channels of impact, our empirical analysis exploits a unique set of events in Malawi that exogenously changed access to work on South African mines. After the removal of a binding national labor quota on recruiting in 1967, migration of Malawian workers to South Africa surged by 200%. Areas with historically easy access to mine recruiting stations established in the early 1900s experienced the largest increases in migration rates. In some districts, over 20% of working age men worked abroad. After a plane transporting migrants back to Malawi crashed, killing over 70 workers in April 1974, a ban on labor was imposed and existing mineworkers were recalled, putting an end to the massive scale of circular migration at that time. Paralleling these shocks to labor migration, capital inflows to Malawi increased by 20%, with much larger inflows to districts with historically-placed recruiting stations.

Our difference-in-differences research design examines changes in local labor market outcomes over time, separately by gender, comparing districts with exogenously high versus low exposure to these migration shocks. We explain and show that the historical placement of recruiting stations is unrelated to a variety of variables correlated with local labor market outcomes, and we use newly digitized historical Census data to control for factors that might affect differential trends across areas of high and low migration. One of novel feature of our paper is that having detailed archival data on the flows of men and money back to Malawi, we are able to tease out the impact of missing men versus the impact of additional capital on these long run labor market outcomes. We include both measures of labor migrants and capital inflows at district level in our difference-in-differences regressions and use independent variation in each

[3] There are other possible reasons for persistence of labor market effects in the long run. For example, attitudes towards women working at all, or in certain occupations may have changed after the labor migration shocks (Goldin and Olivetti 2012, Bellou and Cardia 2015). We plan to test for these channels in future work, using data from the earliest *Demographic Health Surveys* on attitudes towards women's work in Malawi.

to identify OLS coefficients. We can then compare the effects of men, and the effects of money, on changes in rural labor markets over twenty years.[4]

We have three main findings. In the short run, local economies with the highest exposure to the labor migration shock have lower rates of female labor force participation (LFP), lower rates of men and women working in subsistence agriculture, larger shares of women in home production and larger shares of men and women working for others. The shift in female time out of work and into home production is consistent with a large positive income shock that reduces the marginal value of time working outside of the home. In the longer run, areas with the most exposure to the labor migration shocks still have lower female labor force participation rates, and lower shares of men and women in subsistence agriculture, but much higher shares of men and women in self-employment and higher shares of women working for others and for family businesses. We see these changes reflected in sectoral shifts in the high labor migration areas: over time, a lower share of workers (particularly men) work in agriculture and a higher share of workers are employed in the service sector, two decades after the labor migration shock. Finally, we decompose the long run effects of the labor migration shock into the effects of missing men and the effects of returning capital flows. We show that the size of the capital shock in the mid-1970s is important for shifting men and women off the farm into self-employment and into working for family businesses and others.

Our findings contribute to several literatures. Economists have shown that migration, at least at the individual level, is an important pathway out of poverty for migrants and their families (for example, Clemens 2011), but there is little evidence on how access to migration affects the structure of work in agricultural, sending communities. Recent work on the development impacts of seasonal guest worker programs hints at the immediate positive impacts on sending areas (Gibson, McKenzie and Rohorua 2013). Our work complements these findings from a longer run perspective. Second, there have been few tests of the idea that migration provides a channel through which capital can move to where it is needed and that labor exports from rural areas can be a strategy for promoting economic growth and labor reallocation (Foster and Rosenzweig 2008). Our findings suggest that lack of access to capital is an important

[4] We are working on adding an instrumental variables strategy to the results. Although it is not clear that the sources of endogeneity we would be worried about for each of the migrant and capital flows is something to worry about when we are trying to identify the difference in effects *between* these two variables.

constraint on structural change in local labor markets, and that labor migration presents one way to overcome these constraints.[5] Third, our findings of the importance of the capital accumulation mechanism speaks to a large remittances literature that is often concerned with whether migrant earnings are used for consumption or investment (e.g. Yang 2006; Beegle, Dercon and de Weerdt 2006). Finally, from a policy and research perspective, circular migration is highly prevalent in Africa. Figure 1 provides a window on this prevalence: it shows the share of working age men who were missing from their respective countries in SSA and at work on South African mines between 1920 and 1990. Levels of male migration are very high, and many of the nine countries experienced large fluctuations in this legal, contract migration over the 20th century. While mine migration has shrunk dramatically since the 1990s, the legacy of these migrations may persist.[6] Learning from historical events like those in Malawi reveals a critical role for building the infrastructure to channel capital flows back to rural sending economies, in order to facilitate some measure of structural change. These lessons are relevant for many countries currently considering guest worker and seasonal worker programs around the world.[7]

Our paper begins with a description of the nature of rural labor markets in Malawi and the labor migration shocks we use in our empirical work. We set out a conceptual framework for thinking about short and long run impacts of these labor migration shocks and then describe the data and empirical strategy before turning to a discussion of results and a preliminary conclusion.

1. Characteristics of labor markets in Malawi

To provide some context for our analysis, we first describe the economic activities that men and women are involved in, on-farm, off-farm, in the household and how these activities have shifted over time. Then we detail the nature of labor migration shocks in Malawi.

i. Rural labor markets

Agriculture has contributed less and less to the Malawian economy over time. In the 1960s, agriculture accounted for 45% of GDP; by the early 1980s this had shrunk to one-third of GDP.

[5] Another dimension of structural change is urbanization. Since the share of population living in urban areas in Malawi is only 14% in 1998, it is clear that most workers are still working in rural labor markets. However, we do look at urbanization as a separate outcome in our empirical analysis.
[6] See Dinkelman and Mariotti (2015) for an analysis of the long run effects of labor migration on human capital investments of the next generation.
[7] For example, Malawi is contemplating a guest worker program with South Korea (Mponda 2013).

At the same time, the share of manufacturing rose to 12% and the share of services in GDP rose to 45% (Chipeta and Mkandawire 2004), indicating some measure of structural change. Despite these shifts, most employment is still in agriculture, or connected to the agricultural sector. In 1998, almost 80% of working men and 90% of working women (ages 10 to 65) worked in the agricultural sector (Census 1998).

Men and women are typically involved in several types of agricultural work. Working on one's own farm, or doing *mlimi* (subsistence agriculture), engages a higher share of women than men. In the summary statistics from Census 1977 and 1998 shown in Table 1, we see that 50 to 60% of women report working as *mlimi* while only 40 to 45% of men work as *mlimi*.[8] Working for others on a short-term basis (as *ganyu* or day laborers), or as wage employees or as tenant farmers on estate farms is predominantly a set of male activities. Both genders produce food (subsistence) crops on their own farms, but cultivating higher value-added export crops has historically been the purview of men (Wodon and Beegle 2006). Men also fish and engage in animal husbandry at higher rates than women do (results not shown).

Labor force participation in this setting is high, and highest among women (83-90% female labor force participation, Table 1). Part of the difference between male and female labor force participation rates stems from time spent in home production, which is almost exclusively a female activity: 30% of women engage in home production in 1977 while only 1.9% of men do (Table 1). Home production includes any "overhead time" needed to sustain the household, including cooking, cleaning, fetching wood and water. Home production activities also account for the longer working hours reported by women relative to men in time use diaries from Malawi (Wodon and Beegle 2006). Over time though, the share of women in home production has fallen dramatically from 30% to 12% in 1998.

In Figure 2, we show the distribution of employment across sectors outside of agriculture for men and women over time (1977 and 1998). Shares are population-weighted, and industrial classifications are consistent in Census questionnaires over time. Outside of agriculture, work is concentrated in manufacturing (for example, beer brewing and furniture construction),

[8] Wodon and Beegle (2006) differentiate male and female tasks within subsistence agriculture. Men tend to clear land and harvest, while women are responsible for weeding and selling, suggesting that male and female tasks are not perfectly substitutable.

construction, retail and household services (including, for example, cooks, guards and housekeepers). The most pronounced shifts into the service sector between 1977 and 1998 have been in retail and household services employment, for both men and women. Of those men and women who report working for themselves in 1998 (Table 1: 7.2% of men and 2.2% of women), the vast majority report working in the retail sector.

A final sector of work involves international labor migration. Because Malawi is a poor country with high population density and few natural resources, labor exports have always been prevalent in the economy. In the early twentieth century, both men and women migrated to nearby Rhodesia to work in the agricultural sector, although this outlet dried up by the 1950s (McCracken 2012). Historically, men had another important channel for international labor migration: they could choose to work on the gold mines in South Africa. Men signed up at mine recruiting stations (*Wenela* stations) established in certain districts of Malawi by 1937 (shown in red in Figure 3) and made the journey to the mines for contracted work lasting 18 to 24 months (Jeeves 1987, Crush et al 1991).[9] Mine work was generally more lucrative than any wage-earning opportunities at home and Malawian miners were forced to save up to 60% of their earnings and receive this as "deferred pay" upon return to Malawi. Through this mechanism, miners could bring home 2.5 times as much income as they would have earned during a year working on one of the local agricultural estates. The deferred pay formed the basis of their ability to accumulate capital for use back in rural sending regions.

ii. Shocks to labor migration and capital accumulation

Figures 4 and 5 illustrate the shocks to labor migration and capital inflows in Malawi in the 20th century. Starting in the early 1900s and up until the mid-1960s, labor quotas controlled mine migration to South Africa. Although quotas varied annually, they were never more than 2% of the working age male population. In 1967, following the removal of all labor quotas, mine migration expanded rapidly (See Dinkelman and Mariotti 2015 for further discussion), from 40,000 to over 120,000 in five years. In April 1974, a *Wenela* plane returning to Malawi crashed,

[9] *Wenela* stands for the Witwatersrand National Labor Authority. Members of the South African Chamber of Mines gave this agency authority for recruiting mineworkers from across the southern African region. *Wenela* merged with the South African recruiting agency in the mid-1970s and became *Teba*, The Employment Bureau of Africa. Much of the archival material we use in our analysis are original documents from *Wenela/Teba*. See the data section for more details.

killing all miners. Then-president Banda immediately banned all labor recruiting in the country and recalled all foreign workers. The number of Malawians working on South African mines fell to zero in two years (it took some time for *Wenela* to repatriate all of the workers). Although Banda realized that mining money represented a crucial source of foreign exchange for the country and rescinded the ban in 1977, mine migration never recovered because *Wenela* refocused recruiting strategies towards the South African labor market.

Using the variation in Figure 3 showing the location of mine labor recruiting stations across the country, we generate a reduced form measure of exposure to these labor supply shocks at district-level. In percentage terms, the average *Wenela* district experienced a 24 percentage point increase in total number of migrants over this period (summary statistics, Table 2). The number of adult men from *Wenela* districts who had ever migrated to work was around 21,000 in 1977, on average within a district. With an average of 30,000 households per district, this means about 70% of households had some connection with an international labor migrant.

Figure 5 shows how money per capita flowed back to *Wenela* and non-*Wenela* districts between 1966 and the mid-1970s. Before the 1974 plane crash, money would have returned to districts along with migrants as deferred pay or prior to their return as voluntary remittances and deposits. Using our archival data, we know that the majority of these capital flows (89%) were in the form of deferred pay. Over the period of interest, capital flows back to Malawi rose about 20%. Summing up total money received by district between 1966 and 1975, averaging across years and dividing by district-level population in 1966, we calculate that capital flows back to *Wenela* areas rose over 125% by the middle 1970s. Annually, this translates into each migrant brining back between 276 and 691 more Kwacha between 1966 and 1975 (equivalent to about 230-575USD per miner).[10]

Since both male and female labor are used intensively in the agricultural sector in Malawi, the loss of male labor associated with migration to South Africa, along with these massive inflows of money, could have had large effects on the way rural labor markets work over the short and long runs.

[10] In 1975, 1 USD cost 1.2 Malawian Kwacha.

2. Conceptual framework

What might have happened to female labor in the wake of one third of men being absent at some point in the ten year period? What might have happened to male and female labor after many households experienced income shocks equivalent to two times the annual earnings from estate work? We set out a framework for thinking about these effects in the short run and in the longer run.

i. Labor-leisure trade-offs within the household

Assume that male and female labor can be used in home production (meals, *homeworkers*), in own farm production (*mlimi* and *working for farmily*), in market work for an exogenous and constant wage (*working for others*), and in self-employment (think of this as entrepreneurial activities; *working for self*). Any time not spent in work is leisure (*not working*).[11] Households consume maize produced on their own farms or bought on the market, and require a minimum level of home production for this consumption to occur (e.g. meals, water and firewood collection). Households maximize utility from consumption and leisure by choosing the allocation of male and female time across activities.

Male and female time are imperfect substitutes in home production and market work (male wages are higher than female wages in the market, and female time is more productive in the home than male time), but perfect substitutes in self-employment and own farm work. Because of the minimum level of home production required for subsistence, households may not be able to allocate labor to equate marginal productivities across all activities. Instead, men and women will choose to allocate time to different activities such that the last unit of time in that activity is equal to the shadow wage in home production.

Households must incur a one-time fixed cost in order to put any time into self-employment. This fixed cost of entry is the source of a poverty trap. Although returns to time in work are higher in self-employment than in market employment over some range of the self-employment production function, households can only access these higher returns if they can pay the fixed cost. The implication is that without the ability to borrow, or to save, households are unlikely to

[11] We treat market wages as exogenous and fixed in this setting, since in practice, only a very small share of workers are earning wages. Moreover, rural wages are subject to a minimum, according to national regulations.

put any time into off-farm self-employment. This is more likely to be the case for the poorest households, who will be constrained to allocate time only over home production, subsistence farming, market work (if the home production minimum constraint is met) and leisure.

ii. Household adjustments to migration shocks: Migrants and capital in short run

Men migrate, and the shadow wage of time in home production rises. The negative labor supply shock that hits the household when men leave forces a reallocation of remaining labor across sectors that equates the new marginal products of labor with the new shadow wage of time in home production. For example, if women are involved in home production, some market work, some own-farm activity and some self-employment, removing men from the household implies that female marginal product increases in all of the activities which were also using male labor.

To meet the minimum home production constraint, women shift time into this activity and away from other activities. It is possible that women are cannot optimally reallocate labor to all activities: that is, their shadow wage in home production rises so high that they put all of their non-leisure time into that activity and withdraw from own-farm production and market work (and self-employment if they were originally doing this). Households are strictly worse off, as leisure and consumption fall.

However, if men send money back home, the additional income will offset the effects of reducing male labor supply in the household.[12] Through a pure income effect, households will consume more and take more leisure by reducing time in market work, self-employment, and farm production as long as female labor alone can meet the minimum labor requirement in home production.[13] At the same time, households may choose to invest some of the additional income in profitable non-farm activities. For households not initially involved in self-employment, the return of migrant money makes self-employment profitable in the short and longer runs. Labor reallocates away from market work, own-farm work, and home production, and into self-

[12] Any general equilibrium effects of missing men on local wages will tend to reinforce this income effect.
[13] Households may use the income to invest in inputs to improve agricultural productivity. We abstract from this channel of influence for now, but will be able to say something about impacts on agricultural productivity using successive waves of nationally representative agricultural surveys from the 1960s through 2000s.

employment. This frameworks then suggests that for a given number of migrants, more money flowing back should cause more of a shift into self-employment in the short run.

iii. Long run effects

How do any short run effects translate into long run effects? What are the mechanisms for persistence? The mechanism we focus on in the paper is through capital accumulation. Labor migration allows migrants to save enough, and when they return home, they can invest in profitable non-farm activities. We should see sectoral shifts in the allocation of labor across agricultural and non-agricultural sectors in the long run.

There are other channels for persistence that we will eventually be able to test. For example, if labor migration changed attitudes towards women's work, this may have specific long run effects on the structure of women's work, and particularly in areas where baseline attitudes were against women working in certain sectors outside of the home. In addition, returning labor migrants may have accrued some human capital while on migrant contracts. We will try to separate out the human capital effect from the role of financial capital in the long run by separating the effects of migrating men from the effects of their money at the district level.

3. Data

i. Census data

Our main sources of data for labor market outcomes and controls come from multiple years of Census data. We digitized historical Census data available at the district or district-age group-gender level from 1931, 1945, 1966 and 1977 and combined this with district-age group-gender level Census data from 1998.

Labor market outcomes data: Census 1977 and 1998

Using each of the Census years, we construct a set of consistent definitions of male and female labor market outcomes and aggregate to the district-age group-gender level when possible. We use age categories available in the 1977 Census: ages 15 to 19, 20 to 24, 25 to 44, and 45 to 54 and 55 to 64. Key labor market variables include: general employment status (working/not-working), specific labor market activities (self-employed; working for others as

employee; working in a family business; subsistence farming as *mlimi* and home production[14]) and broad categories of occupation and industry of work (e.g. agricultural, manufacturing and services). The Data Appendix describes the wording of employment questions in the 1977 and 1998 Census and shows how we construct consistent definitions across years.

The Census was conducted during a dry season month (June-September) in both Census years, after harvesting and before the next planting cycle, at a time when the marginal product of labor is typically lowest both on and off farm and when people have the most food and cash on hand (e.g. see Goldberg, 2015). This alleviates concerns about employment patterns differing systematically across years because of differences in seasonality. Note however, that even though the timing of the Census is at a low marginal productivity of time in the year, extensive margin participation in the labor market is still high, and highest among women (see Table 1).

Historical and geographic controls: 1931, 1945, 1966 Census and other geographic data

We digitize aggregated data from older Census waves to construct baseline controls at district-level and district-age group-gender level for our analyses. Means of these variables are shown in Table 2. Variables include population density from 1931, adult literacy rates from 1945, the share of married men and women in 1966, and the share of men and women receiving any cash from work activities in 1966. We also include indicators for whether there is an agricultural estate in the district (growing one of the export crops: tobacco, cotton, sugar or tea) and for whether the malaria risk is likely to be high based on average altitude in the district.

ii. Administrative data

We collect, digitize and combine several sources of administrative data to measure variation in the costs of labor migration at district-level and document labor migration and remittance flows.

Recruiting stations by district

The main source of data for locating the *Wenela* recruiting stations as of 1937 come from "Correspondence from the Secretariat, Zomba, Nyasaland 1935 (Circular number 8 1935,

[14] In 1977 and 1998, home production is a subcategory of the "inactive" group. We reclassify home production as an economic activity and regard it as an alternative form of work.

S1/169/35). We verified these stations were still open in later years using information from later Provincial Administration Reports (Northern Province: 7th December 1961 Ref. No. O.3.37 and Commissioner for Labour Circular, 25th March 1957) and from personal communications with the current Malawi TEBA office manager, Michael Ridpath. These data are also used in Dinkelman and Mariotti (2015). We reproduce Figure 2 from that paper as Figure 3 here, to show geographic variation in placement of recruiting stations across the country. All regions had access to some recruiting station and 62% of districts had at least one recruiting station.

Total Migration flows by district between 1966 and 1977

We construct national labor migration totals from a variety of sources including: Chirwa (1991 for years 1950-1958); Lipton (1980: for years 1959-1994); Crush, Jeeves and Yudelman (1991: 234-235) and various years of TEBA (The Employment Bureau of Africa) Annual Reports. We reproduce Figure 1 of Dinkelman and Mariotti (2015) as Figure 3 to show the national variation in mining employment of Malawians between 1950 and 1990. The figure shows clearly the impact of the new labor treaty in 1967 on Malawian mine workers and the impact of the labor ban initiated after the plane crash in 1974.

We used Census 1966 and Census 1977 data to create district-level total flows of migrants between 1966 and 1977. That is, we subtract total migrants in 1977 at district-level from total migrants in 1966 at district-level. We are working on using archival data to create a district-time specific series of migration flows.

Return flows of capital by district between 1966 and 1975: Deferred Pay, Remittances and other capital

We collected and digitized original records of the total amounts of deferred pay, remittances and other deposits made by miners to specific Malawian districts, by month and year, for 1966 through 1974, when repatriation of migrants had concluded.[15] Prior to 1971, the local currency was the British pound, so we convert all money flows to Malawian Kwacha. Since 89% of total money flows over the period were in the form of deferred pay, the amount of money that miners

[15] These records come from documents entitled "Attestation and Despatch Returns to the Ministry of Labour", found in Malawi's National Archives in Zomba and in the TEBA Archives at the University of Johannesburg, South Africa.

were required to save and receive only upon return to Malawi, we use only this source of capital in our analysis.

Figure 4 show time-variation in these flows of deferred pay at district-level per capita between 1966 and 1975 for *Wenela* and non-*Wenela* districts. We see that districts with at least one recruiting station received larger capital flows in every year between 1966 and 1975, and that the gap in capital flows starts to widen around the middle of the period, when the largest number of migrants would have been returning home. The largest shock to capital inflows occurs at the time of the plane crash, when the number of returning migrants would have been at its highest in each district. Capital continues to flow after the labor ban is in place, until all migrants have returned home.

One final point about these capital flows: although we treat these flows as district-specific, the direct effect of this money would have been on migrant households and extended families. Hence, the per-capita amounts we compute from our data, while low at the district level, would have been extremely high, and represent extremely large income shocks, to families of migrant workers.

4. Empirical strategy

Our analysis has so far established the following facts. First, migration of male miners from Malawi surged between 1967 and 1973, after which it contracted to zero by 1975 and remained low in the years after 1977. Districts with *Wenela* recruiting stations experienced this concentrated shock to migration most intensely. Second, capital flows surged as labor migration expanded, and remained high until all workers returned to Malawi by 1975. The majority of this capital was in the form of deferred pay, and through this mechanism, *Wenela* districts experienced the largest total and per capita capital inflows through the shock years.

We ask three questions to understand how and why these labor and capital shocks affected local labor markets in the short run and the long run. What are the immediate, short run impacts of the labor supply and capital shocks of the 1960s and 1970s on women and men's work, on their occupational choices and sector of employment? Do the effects of these shocks persist into the long run? And if they do, can we show whether the shock to labor or to capital played the more important role in generating these long run responses to the shock? Our conceptual

framework suggests that if the mechanism for change in the labor market was through access to capital that enabled families to cover fixed costs of starting some off-farm activity, then we should see that the size of the capital shock is important in accounting for long run results.

To investigate each question, we combine administrative, Census and survey data to estimate variants of difference-in-differences models. Throughout, we consider the labor migration shock as happening at one point in time (i.e. before 1977) and do not exploit the time series dimension of variation in labor or capital flows.[16]

i. Estimating Short Run Effects of Labor and Capital Supply shocks on Women and Men's Work and Occupations

We examine differences in labor market outcomes using the cross-sectional variation in exposure to the migration shocks and control for a range of baseline district-level variables that likely affect the structure of labor markets. We estimate the following cross-sectional regression of various employment outcomes Y_{ad} for cohorts (a) aged 15 to 64 in districts d, and exploit district-level variation in exposure to the migration shocks measured as the presence of any *Wenela* station in that district:

$$Y_{ad} = \beta_0 + \beta_1 Wenela_d + X_a'\gamma + W_d'\lambda + \varepsilon_d \qquad (1)$$

We estimate separate regressions for men and women. Outcomes Y_{ad} include the share of men and women in each cohort that report working at all, the share who work as subsistence farmers (*mlimi*), who are home workers, self-employed, wage workers or who work in a family business (without pay). We also create measures of the share of men and women (across all ages) in broad industry categories (agriculture, manufacturing/production, and services) that we use to look at labor reallocation over the long run.

The regression controls for cohort dummies (X_a) and district-level labor market controls (W_d) that are likely important for labor market outcomes over time: population density in 1931, adult literacy in 1945, an indicator for malaria risk in the area, the share of (men or women) receiving any cash income from work in 1966, and an indicator for an agricultural estate in the

[16] This contrasts with Dinkelman and Mariotti (2015), in which we use time series variation to map increases and decreases in labor migration at district level between 1967 and 1977 to impacts on human capital of children of different ages during these years.

district. Because the 1966 Census did not collect the same labor market variables as later Census data, we cannot use a difference-in-differences approach to estimate changes over time within each district before 1977. Instead, we include controls for the 1966 share of workers with any cash income, as we think this is a critical measure of the state of the local labor market in 1966, prior to the uptick in migration to South Africa.

To interpret β_1 in (1) as the causal effect of migration shocks on employment outcomes in the late 1970s, we assume that once we control for region fixed effects and all of the baseline district-level variables, *Wenela* and non-*Wenela* labor markets only differ in ways related to historical ease of access to mine migrant labor. In all of our analysis, we require that the placement of recruiting stations is uncorrelated with unobservables that independently drive labor market outcomes. There are two important issues to explore here. First, was the placement of *Wenela* recruiting stations as-if random back in the 1930s? Second, did the early placement of stations have impacts on local labor markets even before the labor migration shocks of the 1960s and 1970s, and would the impacts that we estimate have occurred even in the absence of the labor migration shocks?

We deal with the first issue in Dinkelman and Mariotti (2015). We explain how, since mining authorities from South Africa decided where to locate stations and were primarily motivated by the promise of abundant, cheap and healthy labor, location decisions were likely strongly influenced by population density, by local competition for labor, and by local malaria risk. In Table 3, we show that an indicator for whether there is any recruiting station in the district is not significantly related to observable variables that may be correlated with important unobservables affecting labor market outcomes.

In terms of the second issue: the first best response would be to establish empirically no differential pre-trends in labor market outcomes across *Wenela* and non-*Wenela* stations. Although data limitations prevent us from directly testing the parallel-trends assumption for labor market outcomes, it helps that recruitment rates of these historically-placed stations were fairly low. There is unlikely to have been very large differences in the evolution of labor markets across recruiting and non-recruiting stations prior to the period we examine. Our host of baseline district-level variables that are likely correlated with labor market trends (e.g. population density, presence of a local estate) are important controls in our regression. And, in terms of human

capital differences across district, we know from Dinkelman and Mariotti (2015) that there are no pre-trend differences across *Wenela* and non-*Wenela* districts in education of the working age population.

ii. The Long Run Effects of Migration Shocks on Male and Female Work

We combine data from the 1998 and 1977 Census waves to observe what happens among adult cohorts in the twenty years following the labor migration shocks. Note that some of the adults we examine in the later years would have been children at the time of the labor migration shocks. For example, someone who is 20 years old in 1998 was not born in 1977. Cohorts older than 40 in 1998 would have likely been able to work in 1977; in contrast, all younger cohorts in each year would not yet have entered the labor force by 1977. These examples make clear that we estimate the persistent impact of the labor migration shocks of the 1960s and 1970s on some share of the next generation of adult workers.

To examine the longer run impacts of the labor migration shocks of the 1960s and 1970s, we use the same measure of migration exposure described above (an indicator for *Wenela* station in the district) to estimate separate differences-in-differences regressions for men and women:

$$Y_{adt} = \alpha_0 + \alpha_1 WenelaStation_d * Post_t + \alpha_2 WenelaStation_d + \alpha_3 Post_t + X_a'\gamma + W_d'\lambda + \mu_d + \varepsilon_{adt} \quad (2)$$

The parameter estimate α_1 captures differences in employment outcomes among men (or women) in districts with high versus low exposure to migration shocks, conditional on district fixed effects and a $Post_t$ dummy (=1 for observations from 1998), controls for cohort characteristics (X_a) and baseline district characteristics (W_d). $Post_t$ controls for aggregate changes in the labor market that affect all workers equally, and district fixed effects (μ_d) control for constant average differences in labor markets across districts. Again, the key challenge to identification in this regression is that we must assume that districts with high versus low migration exposure would not have changed (in terms of labor market outcomes) differentially in the absence of these migration shocks. In this case, we can go further than including district fixed effects and baseline district controls. In our most comprehensive specification, we include controls for each of the district-level variables (interacted with a $Post_t$ dummy to help us control for remaining confounders.

iii. Exploring Mechanisms: Access to Capital

One of the channels through which labor migration shocks could affect rural labor markets in Malawi, both contemporaneously and over the longer run, is through access to capital from outside the country. In our simple labor-leisure model, deferred pay earned through migration augments wealth, which could help households defray the fixed cost of entry into self-employment and set them up for persistent changes in labor allocation across sectors.

To investigate the importance of the capital versus labor flows, we estimate the following difference-in-differences regression for the same labor market outcomes and for men and women separately:

$$Y_{adt} = \lambda_0 + \lambda_1 LnMoney_d * Post_t + \lambda_2 LnMigrants_d * Post_t + \lambda_3 LnMoney_d + \lambda_4 LnMigrants_d + \lambda_5 Post_t + X_a'\gamma + W_d'\lambda + \mu_d + \varepsilon_{adrt} \quad (3)$$

The estimate of λ_1 tells us the percentage point change in the relevant employment outcome (Y_{adt}) in response to a one percent increase in male migration. Similarly, the estimate of λ_2 tells us the percentage point change in the relevant employment outcome in response to a one percent increase in capital flows over the period. $LnMoney_d$ ($LnMigrants_d$) is the natural log of total deferred pay (migrant worker) flows per person in the district between 1967 and 1977. District-level population is measured in 1966. The regression controls for a post indicator, age cohort indicators, district fixed effects, all the prior baseline district-level variables, and interactions of these baseline district variables with the post dummy. We are interested in knowing both the sign and significance of each of λ_1 and λ_2.

To interpret estimates of λ_1 and λ_2, it is important to understand why there is independent variation in male migration shocks and capital shocks. For example, it is possible to find districts with the same number of men returning to Malawi and a different level of capital flowing back, as well as the reverse – districts with the same level of capital, but different numbers of migrants. As previously described, the amount of money sent back to Malawi is largely a function of the amount of deferred pay accrued by the worker. The wage contract determines the share of earnings devoted to deferred pay. Differences across districts arise from differences in the share of returning miners who are novices versus on higher order contracts (re-contracted miners earn

more); differences in rules about deferred pay percentages over time; and differences in the number of men returning home at different points on their contracts. This last source is particularly relevant following the shock in 1974: men were not able to finish out their contracts, and so the total amount of deferred pay returning to districts is plausibly exogenous to the composition of miners abroad at the time.

We are currently working on an instrumental variables strategy to estimate the effects of men versus money. Our instrument for the total number of men returning to the district is whether there is a recruiting station in the district (see Table 4 for the first stage). Our instrument for the total amount of deferred pay returning to the district will be a measure of the district-specific share of workers on repeat contracts at the time of the plane crash in 1974.

5. Results and discussion

i. Reduced form results

In Table 5, we present the results of our analysis of the short run impacts of exposure to the labor migration shock on labor market outcomes for women (Panel A) and men (Panel B). We exploit cross-sectional variation in exposure to the migration shock by comparing outcomes measured in 1977 across districts with any recruiting station, relative to those without any recruiting station and controlling for a set of baseline district-level variables. These controls capture pre-existing differences between *Wenela* and non-*Wenela* local labor markets. Controlling for baseline differences in local labor markets is important for the results; R2 statistics in all regressions except for working in a family business are very high, suggesting that our controls capture almost all of the cross-district-age group variation in labor market outcomes. Regressions are weighted by population. We cluster standard errors at district level, and indicate statistical significance using the small-sample *t* distribution for critical values.

In the first column, we see that exposure to the labor migration shock reduced female work on the extensive margin by 3.8 percentage points, but had no significant impact on male work on the extensive margin. This is indicative of an income effect operating for women: more money returning to districts should induce households to take more consumption and more leisure at the expense of the lowest marginal productivity labor. These impacts are large. It remains to be seen how much of this change in persistent in the long-run and whether the change in female LFP

rates is driven by the number of men returning or to the change in capital accompanying these men.

In the short run, exposure to the labor migration shock substantially shifted the structure of work for men and women (the denominator in all regressions is the total number of men and women in each district-age group). Across *Wenela* and non-*Wenela* areas, there are significantly more women working outside of subsistence agriculture immediately after the labor migration shock. Women in districts with any recruiting station are 21 percentage points less like likely to be working in subsistence farming (a decline of one-third) and 12 percentage points more likely to shift their time into homework (an almost 50% increase in this category). Women in *Wenela* areas are almost 5 percentage points more likely to be working for others. Table 5 shows similar shifts in the structure of work for men, outside of home production. Men in high migration exposure districts shift out of subsistence farming (there is about a 50% decline in workers in this category) and exhibit very large relative increases in working for others and working in a family business.

Over the long run, it is possible that the local labor market effects of men migrating and returning wear off. This is particularly the case if households consume all of the earned miner pay immediately. On the other hand, short run effects on the structure of work may persist into the longer run if the migration shock relaxed capital constraints on starting off-farm work. In that case, investment of migration income could lead to persistent differences across *Wenela* and non-*Wenela* areas particularly in those occupations that require some start-up capital.

Table 6 presents the long run results using a difference-in-differences specification that controls for district fixed effects, and then adds in interactions of baseline district variables with $POST_t$. The coefficient on $Post_t*Wenela_d$ station can be interpreted as the differential change in labor market outcomes over time in districts with high versus low exposure to the migration shock. In the long-run, areas with high migration exposure have fewer women working, and no large significant differences between LFP rates of men relative to low migration exposure areas. For both men and women, the structure of local labor markets in *Wenela* areas also changes over time, relative to non-*Wenela* areas. Shares of both men and women in *mlimi* fall, with a much larger shift for women. Women shift their work into home production, self-employment, working for others and working in family businesses. While male LFP rates do not differ over

the long run, there is a 5 percentage point increase in self-employed men, and a doubling of men working in family business. For both men and women, the shifts out of subsistence farm work are large relative to mean levels in each activity. Our results are consistent with access to mine worker earnings facilitating capital accumulation and promoting the expansion of work off-farm.

As a final reduced form set of results, we show the shifts in sector of work for men and women across *Wenela* and non-*Wenela* districts between 1977 and 1998 in Table 7 (Panel A, women and Panel B, men). With a single observation per district, gender and year, we have low power to estimate significant effects. Nevertheless, there are large point estimates on $Post_t$*$Wenela_d$ for men in particular, with labor in high migration exposure districts reallocating out of agriculture and into services.

It is useful to think through whether the magnitudes of these shifts are sensible. We will focus on the impact of exposure to the labor migration shock on the share of people that are self-employed. About two-thirds of households had some experience of migration by 1977, and having a recruiting station in the district increases the number of migrants per person by 0.13. In each year, between 16,000 (during the late 1960s) and 75,000 (at the time of the plane crash in 1974) returned to Malawi, which is between 666 and 3,125 men on average per year and district. These men bring back with them a cumulative 64 million Kwacha (53 million USD in 1975) in deferred pay, which is between 276 (in the early years) and 691 (in the later period) Kwacha per returning migrant.

The shift into self-employment over the next twenty years is 2.5 percentage points for women and 5.2 percentage points for men. In an average district with 60,000 men and 60,000 women making up the working age population, this translates into an additional 1,500 self-employed women, and an additional 3,144 self-employed men. Going through the same exercise for the shifts in sector of work: the share of men working in agriculture falls by 3.6 percentage points and the share working in services increases by about the same amount. This is a reallocation of about 2,100 male jobs in the average district. These numbers are not massive – Malawi is certainly no South Korea or Vietnam – but our results suggest some measure of structural change facilitated by exposure to labor migration opportunities.

ii. Separating men and their money

Were these short- and long-run shifts out of local agricultural labor markets the result of "new access to capital" stimulating self-employment and off-farm businesses more generally? We investigate this by separating out effects of the changing male labor supplies through the 1966 to 1977 period from the effects of changing access to capital.

In Table 8, we present results that control separately for migrant flows ($Ln\ Migrants_d$) and total flows of deferred pay ($Ln\ Money_d$). For each outcome, we show estimates of λ_1 and λ_2 from regressions with district level fixed effects, and then from regressions that include interactions of all baseline district-level controls with $POST_t$. First, notice that for many outcomes, the impacts of men and money tend to go in opposite directions. For example, the larger the percent change in money (controlling for migrant flows), the lower LFP is for men and women (although only significantly so for women). At the same time, both men and women work more over time in areas with large capital flows. These long run effects on the extensive margin of work are smaller than the short run effects, suggesting that the immediate positive income effect of additional migrant earnings on leisure (non-work) wears off over time.

At the same time, large income shocks also appear to facilitate movements out of subsistence farming and into self-employment and family business work for both genders. For each one percent increase in capital inflows, shares of men and women working in subsistence agriculture fall by between 2.6 and 6.8 percentage points, and the share in self-employment rises by between 0.8 and 1.8 percentage points. While the shifts into off-farm work (self-employment, working for others and working in family business) are small in percentage point terms, they represent very large changes relative to mean employment in these activities. For example, self-employment rises by between 33 and 62% in districts with a 1% shock to capital flows over the period. Larger capital flows, conditional on total migrants, are also associated with greater shifts into home production and working for others among women. These long run results are consistent with the idea capital accumulation through labor migration played a crucial role in affecting the structure of local labor markets over the long run.

iii. Extensions

We are in the process of completing two extensions to our main results. Each extension gives us more insight into the process through which these labor exports from Malawi facilitated structural change.

First, we look at urbanization as a distinct outcome over time. Using this measure, we can go back to the earlier Census years and look at urbanization rates across *Wenela* and non-*Wenela* districts from 1945 onwards. Initial results suggest that some of the reallocation of labor away from agricultural work accompanies a movement of population from rural towards more urban areas within-districts, and that these shifts were not occurring prior to the labor migration shocks.

Second, we investigate the role of internal migration across districts in generating our results. That is, internal migration (in or out of a district) may become more prevalent in areas with the highest exposure to international labor migration. Suppose the high migration exposure districts become desirable for workers in low migration exposure regions, and especially for those workers in the non-agricultural sector. Alternatively, high migration exposure districts may become less desirable for agricultural wrokers to remain in, and so there is more internal outmigration of farmworkers from these areas, towards low migration exposure areas. In both of these cases, our results on the sectoral reallocation of workers could be driven by internal migration changing the composition of local labor markets over time. We will try to bound our results for the extent of cross-district internal migration that we can measure in the various Census waves.

6. Preliminary Conclusions

We posed the question: Can labor migration promote a measure of structural change in sending communities by allowing workers to accumulate capital outside of their country of origin? Answering this question requires plausibly exogenous variation in international flows of circular migrants, enough Census data to provide coverage of labor market outcomes over space and time, good administrative data to document and pin down the separate effects of migrant flows and money flows, and a credible research design to isolate causal impacts of labor migration We use the historical experience of massive circular labor migration between Malawi and gold mines in South Africa to address each of these challenges and investigate how

oscillating flows of labor and inflows of capital affect rural labor markets in the short and long run.

Exploiting two plausibly exogenous shocks to the option to migrate, a difference-in-differences design and newly digitized Census and administrative data, we show what happens to labor market outcomes in the wake of these shocks. Employment falls immediately in places with high exposure to migration shocks and workers shift out of subsistence agriculture. In the longer run, labor continues to shift out of agriculture and into services in high migration shock districts, with self-employment increasing by more than 50%. We isolate capital accumulation as a key channel for these structural changes using archival data on flows of money and men. Although Malawi is still primarily an agricultural economy, we show that access to capital from outside of the country has had long run impacts on the structure of work in rural labor markets. These historical lessons are broadly relevant for any low-income country contemplating guest worker or seasonal worker programs. More work remains to be done on the role of the forced savings aspect of the migration to South Africa in generating the long run impacts.

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Figure 1: Share of adult men working abroad on South African mines by country, 1920-1990

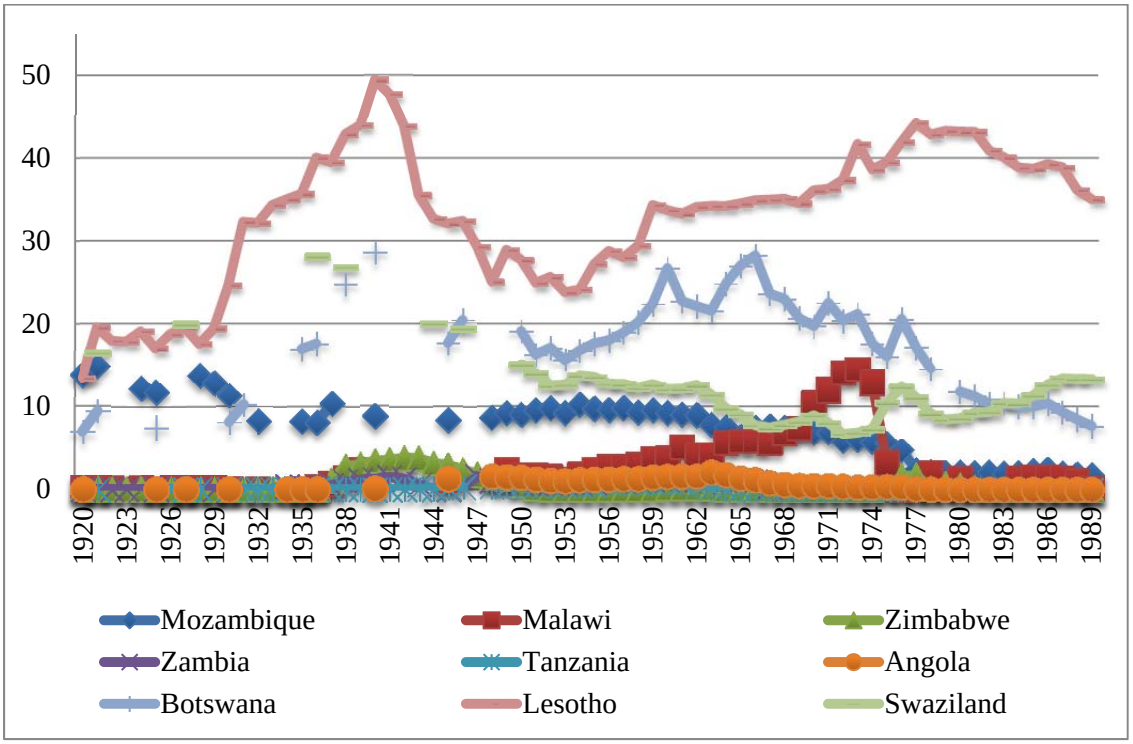

Figure shows percent of working age men employed on South African gold mines. Data on migrant workers from Crush, Jeeves and Yudelman 1991. Data on working age male population from http://www.populstat.info/.

Figure 2: Share of workers employed in each non-agricultural sector, by gender and Census year

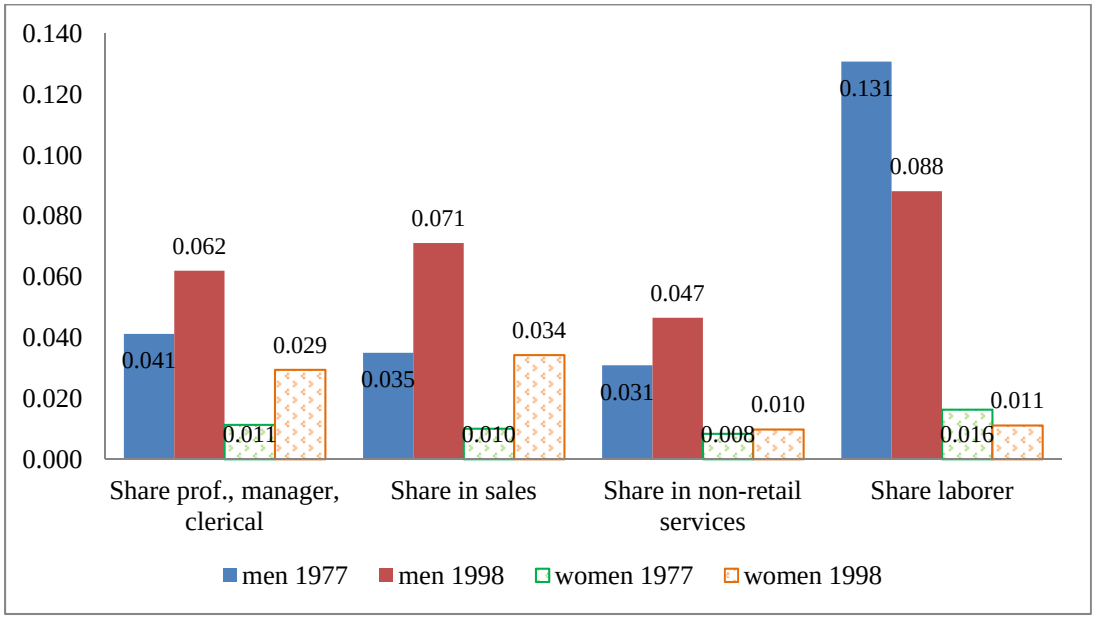

Figure shows the share of Malawian men and women working in each broad non-agricultural sector in 1977 and 1998, at district-level. Means are population weighted. Data are from Malawian Census data in 1977 and 1998.

Figure 3: Spatial distribution of *Wenela* recruiting stations across Malawi

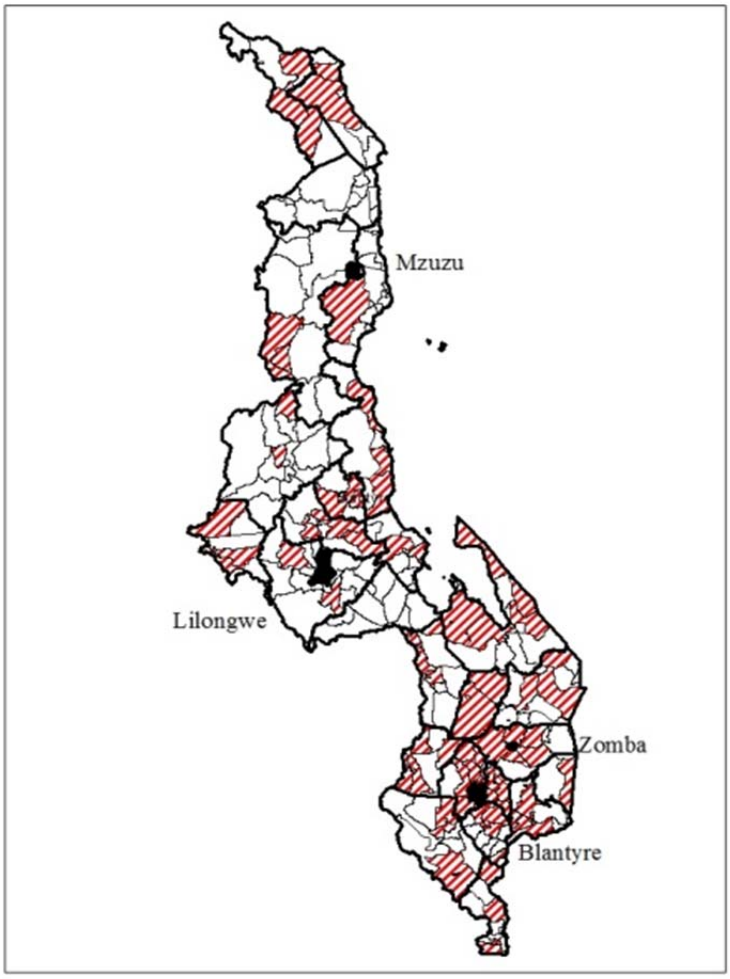

Figure shows district boundaries (thick black lines), sub-district/traditional authority boundaries (thinner black lines) and the distribution of *Wenela* recruiting stations established by 1937 (red hatched areas) across the country. Black shaded areas show Malawi's four cities.

Source: Dinkelman and Mariotti 2015

Figure 4: Annual employment of Malawian miners on South African mines, 1950-1994

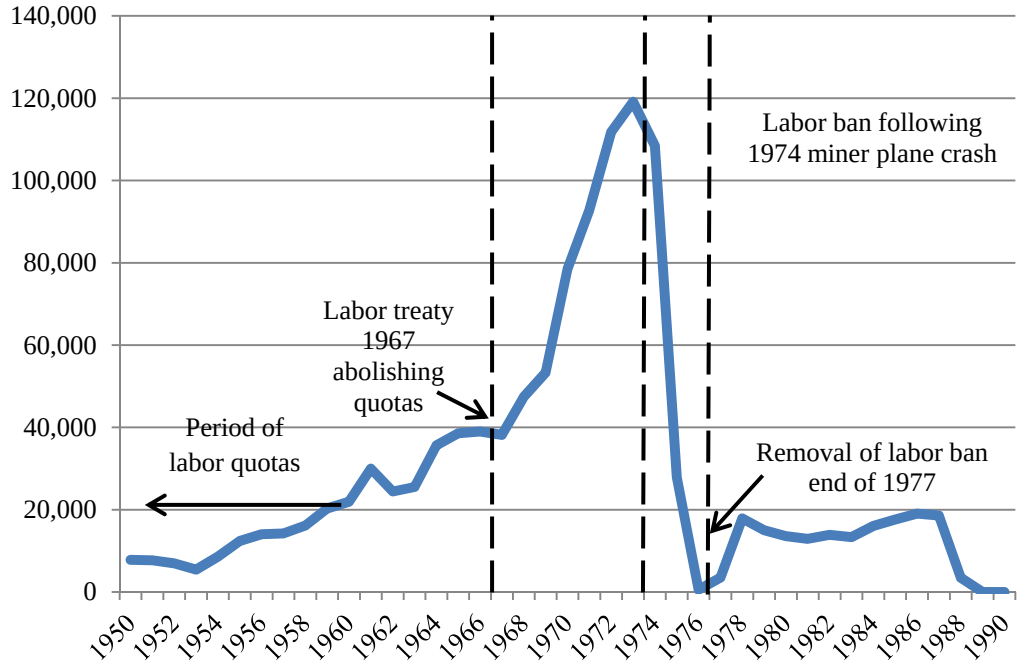

Figure shows number of workers employed on South African mines in each year. The three dotted lines represent (from left to right) the abolition of labor quotas in August 1967, the moratorium on migration after the April 1974 Malawian plane crash and the legal resumption of mine migration in 1978. Source: Dinkelman and Mariotti 2015

Figure 5: Log deferred pay per person received by *Wenela* and non-*Wenela* districts by month and year: 1966-1974

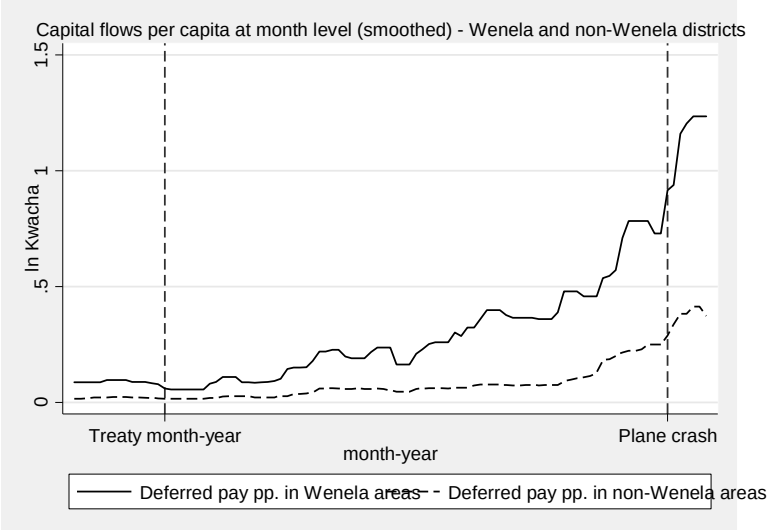

Figure shows the log of total deferred pay in Kwacha per person received by *Wenela* and non-*Wenela* districts for each month and year (smoothed), 1966- 1975. Capital flows cease after 1975. District level population totals are from Census 1966. Data collected from Malawi National Archives and South African TEBA Archives.

ONLINE APPENDIX

Appendix A: Data

Labor market questions in 1977: Ask all persons of 10 years of age or older

- O: Did you work last week? Yes/No?
- P: What was your activity?
    - Active
        - Mlimi
        - Employee
        - Family business worker
        - Self-employed
        - Employer
        - Unemployed
            - Worked before, seeking work
            - Worked before, not seeking work
            - Never worked before, seeking work
            - Never worked before, not seeking work
    - Inactive
        - Home worker
        - Student
        - Dependent
        - Independent
        - Other
            - (Skip): For all inactive people: do not ask Q and R
- Q: What is your occupation? {coded options: clerical, managerial, production, services, technical and sales}
- R: What is your industry of work? {coded options: agriculture, construction, energy, finance, manufacturing, mining, services, transport and wholesale and retail trade}.

Labor market questions in 1998: Ask all persons ages 10 and over the following

- B17: What was X doing in the last 7 days?
    - Active
        - Mlimi
        - Employee
        - Family business worker
        - Self-employed
        - Employer
        - Unemployed
            - Worked before, seeking work
            - Worked before, not seeking work
            - Never worked before, seeking work
    - Inactive
        - Non-worker: never worked before and not seeking work
        - Homeworker
        - Student
        - Other
            - (Skip) If inactive person is female, do not ask B18 and B19
- B18: What is this person's main occupation? {coded options: clerical, managerial, production, services, technical and sales}
- B19: What is this person's main trade or business (industry)? {coded options: agriculture, construction, energy, finance, manufacturing, mining, services, transport and wholesale and retail trade}.

Table 1: Summary Statistics for Economic Activity outcomes

	Short run means: 1977	Long run means: 1998	Difference
	Panel A: Men		
Working at all	0.774	0.739	-0.035
	(0.237)	(0.278)	
Working for family	0.002	0.024	0.022
	(0.002)	(0.014)	
Working for someone else	0.277	0.181	-0.096
	(0.156)	(0.133)	
Working for self	0.053	0.074	0.021
	(0.040)	(0.048)	
Working as *mlimi*	0.422	0.448	0.026
	(0.203)	(0.208)	
Homeworker	0.019	0.009	-0.010
	(0.016)	(0.007)	
	Panel B: Women		
Working at all	0.905	0.830	-0.075
	(0.122)	(0.195)	
Working for family	0.002	0.017	0.015
	(0.001)	(0.013)	
Working for someone else	0.024	0.041	0.017
	(0.018)	(0.034)	
Working for self	0.011	0.022	0.011
	(0.010)	(0.015)	
Working as *mlimi*	0.560	0.630	0.070
	(0.181)	(0.210)	
Homeworker	0.307	0.120	-0.188
	(0.125)	(0.084)	

Means and standard deviations of outcome variables from Census 1977 and 1998. Data are collapsed to district-gender-age group cells, for ages 15 to 44 years (3 age groups) and population-weighted. There are 72 observations in each cell. Working is defined over the entire sample. Working at all, for family, for self, for someone else and as mlimi are all types of work. Homeworker is defined as "inactive" in the Census.

Table 2: Summary statistics for other data

	Wenela Recruiting Districts		Non-Wenela Districts		*p* value of difference
	Mean	s.d.	Mean	s.d.	
Variables measuring exposure to mining employment shocks					
Any Wenela station	1.00	0.00	0.00	0.00	
Number of adult men ever been abroad by 1977~	21,142	18,604	16,914	8,088	0.53
Δ number of migrants, 1966-1977	14,069	12,378	12,929	7,620	0.81
Migrant growth rate, 1966-1977	0.24	0.58	-0.03	0.37	0.24
Total deferred miner pay (Kwacha) per person, 1966-1977	47.59	90.14	13.49	20.81	0.28
District-level controls					
Central Region	0.60	0.51	0.00	0.00	0.00
Southern Region	0.07	0.26	1.00	0.00	0.00
Log Population density 1931	2.58	0.60	3.42	0.80	0.01
English and vernacular literacy, share of youth in 1945	0.09	0.04	0.06	0.36	0.02
Altitude: high malaria area=1	0.20	0.32	0.43	0.36	0.12
Share of districts with any estate	0.40	0.51	0.56	0.53	0.48
Share of men earning any cash income in 1966	0.62	0.12	0.66	0.08	0.33
Share of women earning any cash income in 1966	0.53	0.16	0.50	0.11	0.62
Number of districts	15		9		

Data for the first set of outcomes are district-level data collected from administrative records. Data for the second set of outcomes comes from Census data in 1931 and 1945, and from geographic files for Malawi. *p* values are reported for the test of the difference in means across recruiting and non-recruiting station areas using robust standard errors and evaluated using the small sample *t* distribution to account for the small number of clusters. Estate is a dummy variable indicating whether a district contains any cash crop estates (e.g. for tobacco or sugar). Data on deferred pay are only available for 21 districts.

Table 3: Historical and geographic predictors of Wenela recruiting station placement at district-level

	Any recruiting station in the district			
	(1)	(2)	(3)	(4)
Log population density, Census 1931	-0.332***	-0.385***	-0.296***	-0.088
	(0.089)	(0.079)	(0.100)	(0.094)
Estate district		-0.343*	-0.217	-0.109
		(0.189)	(0.174)	(0.116)
Altitude (meters)^*100			0.07***	0.018
			(0.020)	(0.019)
Literacy rate, Census 1945			-0.137	0.955
			(2.380)	(1.250)
Central region				0.148
				(0.151)
Southern region				-0.619
				(0.363)
Constant	1.855***	0.950*	0.881***	3.622***
	(0.225)	(0.490)	(0.202)	(1.042)
Observations	24	24	24	24
R-squared	0.28	0.38	0.57	0.87
Mean of outcome	0.63	0.63	0.63	0.63

Robust standard errors in parentheses in all regressions. Statistical significance at the 1, 5, and 10 percent levels is indicated by ***, **, and *, respectively, and evaluated relative to the small sample *t* distribution to account for the small number of clusters. Outcome is an indicator for any recruiting station in the district. All variables are measured at district level. Altitude is average altitude for each district and is a proxy for malaria risk. Results are based on Table 2 in Dinkelman and Mariotti (2015).

Table 4: Wenela recruiting stations predict circular migration and money flows 1966-1977

	Δ in number of migrants	*Deferred miner pay (Kwacha) per person*
	(1)	(3)
Any Wenela station	10,502***	329.3***
	(2,652)	(8.018)
Central region	1,946	3.329
	(3,237)	(7.525)
Southern region	5,970	308.8***
	(4,787)	(6.451)
Mean Literacy rate in 1945	-333	21.12**
	(2,458)	(7.860)
Log population density in 1931	-135,518	91.710
	(84,042)	(122.200)
Estates	-9,902**	(2.346)
	(4,706)	(7.933)
N	24	21
R2	0.50	0.98
Mean of outcome variable	3,445	32.97

Robust standard errors in parentheses in all regressions. Statistical significance at the 1, 5, and 10 percent levels is indicated by ***, **, and *, respectively, and evaluated relative to the small sample t distribution to account for the small number of districts. Unit of observation is the district. Outcomes are the change in the raw number (stock) of male migrants between 1966 and 1977, measured at district-level using Census data in 1966 and 1977 (columns 1 to 4) , the change in log number of migrants in 1977 and in 1966, and total deferred pay per person (population measured in 1966) received by each district between 1966 and 1977 (columns 5 to 8). Any Wenela station is an indicator for any station in the district in 1937 (share with any station is ZZ), estate is a dummy for whether the district contains a tea, tobacco, sugar or cotton plantation. Deferred pay data exist for only 21 districts. Results are similar to those in Table 3 of Dinkelman and Mariotti (2015).

Table 5: Impacts of labor migration shocks on labor market outcomes in 1977, by gender

	Working	Subsistence farming	Home production	Own business	Working for others	Working in family business
			Panel A: Females			
Outcome mean	*Mean=0.89*	*Mean=0.60*	*Mean=0.261*	*Mean=0.010*	*Mean=0.016*	*Mean=0.002*
Any Wenela station	-0.0383***	-0.218***	0.122**	0.007	0.0493***	0.001
	(0.011)	(0.056)	(0.048)	(0.008)	(0.004)	(0.001)
R2	0.96	0.81	0.69	0.58	0.76	0.38
N	120	120	120	120	120	120
			Panel B: Males			
Outcome mean	*Mean=0.79*	*Mean=0.505*	*Mean=0.0208*	*Mean=0.052*	*Mean=0.213*	*Mean=0.002*
Any Wenela station	0.018	-0.234***	0.007	0.019	0.222***	0.00202*
	(0.011)	(0.043)	(0.006)	(0.022)	(0.033)	(0.001)
R2	0.973	0.854	0.668	0.737	0.747	0.45
N	120	123	120	120	120	120
All other controls	Y	Y	Y	Y	Y	Y

Standard errors clustered at the district level. Significance levels ***p<0.01, **p<0.05, *p<0.1 where critical values are taken from the small sample t-distribution. Data are Census 1977. Unit of observation is the district-age group-gender cell. Total districts=24, total age group cells for each gender = 5 (Ages 15-19, 20-24, 25-44, 45-54, 55-64). Other controls includes age group dummies, baseline adult literacy in the district in 1945, population density of the district in 1945, a malaria dummy and region dummies, share of men or women married in 1966, and gender-specific shares of workes who earn a cash income from farm produce or other activities in 1966. All regressions are population weighted.

Table 6: Impacts of labor migration shocks on the change in labor market outcomes between 1977 and 1998, by gender

Share	**Working**		**Subsistence farming**		**Home production**		**Self-employment**		**Working for others**		**Working in family business**	
						Panel A: Females						
Outcome mean	*Mean=0.88*		*Mean=0.66*		*Mean=0.176*		*Mean=0.015*		*Mean=0.026*		*Mean=0.0081*	
Post*Any Wenela station	0.007	-0.0479***	-0.057	-0.230***	0.041	0.103**	0.00813**	0.0253***	0.0149**	0.0312***	-0.0001	0.0221***
	(0.013)	(0.017)	(0.042)	(0.042)	(0.040)	(0.039)	(0.004)	(0.005)	(0.006)	(0.005)	(0.005)	(0.003)
R2	0.96	0.98	0.93	0.97	0.87	0.94	0.79	0.85	0.82	0.88	0.73	0.88
						Panel B: Males						
Outcome mean	*Mean=0.787*		*Mean=0.531*		*Mean=0.0145*		*Mean=0.0565*		*Mean=0.17*		*Mean=0.010*	
Post*Any Wenela station	0.01	-0.0147	-0.0454	-0.0487	-0.00131	-0.0017	0.0353***	0.0524***	0.0277	-0.0317	-0.00669	0.0144***
	(0.016)	(0.015)	(0.034)	(0.036)	(0.004)	(0.006)	(0.009)	(0.013)	(0.028)	(0.021)	(0.004)	(0.003)
R2	0.97	0.99	0.93	0.95	0.66	0.80	0.87	0.90	0.85	0.89	0.80	0.94
Other controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
District Fixed effects	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
District controls*Post	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Standard errors clustered at the district level. Significance levels ***p<0.01, **p<0.05, *p<0.1 where critical values are taken from the small sample t-distribution. Data are from Census 1977 and 1998. Unit of observation is the district-age group-gender cell. Total districts=24, total age group cells for each gender = 5 (Ages 15-19, 20-24, 25-44, 45-54, 55-64). Total observations in each regression is 240. Other controls includes age group dummies, baseline adult literacy in the district in 1945, population density of the district in 1945, a malaria dummy, the share of men and women married in 1966, the share of men and women earning any cash income in 1966, region dummies, and interactions of all of these variables with a post dummy. All regressions are population weighted.

Table 7: Impacts of labor migration shocks on structure of work 1977 to 1998 by gender

	Share in Agriculture			Share in Manufacturing			Share in Services		
				Panel A: Women					
Outcome mean	*Mean=0.932*			*Mean=0.0144*			*Mean=0.0458*		
Any Wenela station*Post	-0.0444**	-0.007	-0.007	0.00809*	0.003	0.007	0.0351*	0.003	-0.004
	(0.018)	(0.010)	(0.011)	(0.004)	(0.005)	(0.006)	(0.019)	(0.009)	(0.010)
R2	0.09	0.95	0.99	0.06	0.73	0.87	0.15	0.94	0.98
				Panel B: Men					
Outcome mean	*Mean=0.786*			*Mean=0.075*			*Mean=0.125*		
Any Wenela station*Post	-0.051	-0.043	-0.036	0.007	0.003	0.003	0.0442*	0.0408*	0.035
	(0.030)	(0.031)	(0.038)	(0.017)	(0.017)	(0.022)	(0.023)	(0.024)	(0.026)
R2	0.06	0.84	0.97	0.04	0.79	0.93	0.14	0.83	0.97
Other controls	N	Y	Y	N	Y	Y	N	Y	Y
District FE	N	N	Y	N	N	Y	N	N	Y

Standard errors clustered at the district level. Significance levels ***p<0.01, **p<0.05, *p<0.1 where critical values are taken from the small sample t-distribution. Data are from Census 1977 and Census 1998. Unit of observation is the district-gender cell. Total districts=24. Total observations in each regression is 48. Other controls includes baseline adult literacy in the district in 1945, population density of the district in 1945, a malaria dummy, share of men and women married in 1996, share of men and women working for any cash income in 1966, and region dummies. All regressions are population weighted.

Table 8: Impacts of labor migration shocks on labor market outcomes in 1977, by gender and type of shock

	Working		**Subsistence farming**		**Home Production**		**Self-employment**		**Working for others**		**Working in family business**	
						Panel A: Females						
Outcome mean	*Mean=0.88*		*Mean=0.68*		*Mean=0.16*		*Mean=0.014*		*Mean=0.021*		*Mean=0.007*	
Post*Ln Money	-0.0181*	-0.0121**	-0.029	-0.0679***	-0.010	0.0353**	0.00530*	0.00881***	0.008	0.00660**	0.00812*	0.00500***
	(0.009)	(0.006)	(0.028)	(0.023)	(0.024)	(0.017)	(0.003)	(0.002)	(0.005)	(0.003)	(0.004)	(0.001)
Post*Ln Migants	0.0268*	0.005	0.037	0.109**	0.007	-0.100**	-0.007	-0.00885**	0.001	0.004	-0.0107**	0.001
	(0.014)	(0.011)	(0.068)	(0.047)	(0.053)	(0.037)	(0.005)	(0.004)	(0.009)	(0.005)	(0.005)	(0.002)
R2	0.96	0.98	0.93	0.96	0.86	0.95	0.786	0.845	0.826	0.885	0.78	0.89
						Panel B: Males						
Outcome mean	*Mean=0.80*		*Mean=0.54*		*Mean=0.012*		*Mean=0.054*		*Mean=0.173*		*Mean=0.01*	
Post*Ln Money	-0.00951*	-0.006	-0.0246*	-0.0267*	0.000	-0.002	0.0161***	0.0180***	-0.009	-0.001	0.00702**	0.00513***
	(0.005)	(0.005)	(0.014)	(0.014)	(0.003)	(0.002)	(0.006)	(0.005)	(0.016)	(0.012)	(0.003)	(0.001)
Post*Ln Migants	0.0170*	0.0230**	-0.023	0.009	0.002	0.001	-0.004	-0.008	0.052	0.022	-0.00902**	0.000
	(0.009)	(0.010)	(0.047)	(0.031)	(0.005)	(0.004)	(0.015)	(0.010)	(0.032)	(0.025)	(0.004)	(0.001)
R2	0.975	0.989	0.94	0.95	0.69	0.86	0.867	0.903	0.852	0.887	0.822	0.946
Other controls	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
District FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
District controls*Post	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y

Standard errors clustered at the district level. Significance levels ***p<0.01, **p<0.05, *p<0.1 where critical values are taken from the small sample t-distribution. Data are Census 1977. Unit of observation is the district-age group-gender cell. Total districts=24, total age group cells for each gender = 3 (Ages 15-19, 20-24, 25-44). Total observations in each cell is 210 (deferred pay flows not available for 3 districts). Other controls includes age group dummies, baseline adult literacy in the district in 1945, population density of the district in 1945, a malaria dummy, the share of men and women married in 1966, the share of men and women working for any cash wage in 1966, and region dummies. All regressions are population weighted.