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**Working Paper**

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CReAM

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## Non-Technical Abstract

The impacts of international migration on development in the sending countries, and especially the effects on remaining household members, are increasingly studied. However, comparisons of households in developing countries with and without migrants are complicated by a double-selectivity problem: households self-select into migration, and among households involved in migration, some send a subset of members with the rest remaining whilst other households migrate en masse. We address these selectivity issues using the randomization provided by an immigration ballot under the Pacific Access Category (PAC) of New Zealand's immigration policy. We survey applicants to the 2002-05 PAC ballots in Tonga and compare outcomes for the remaining household members of emigrants with those for members of similar households who were unsuccessful in the ballots. The immigration laws determine which household members can accompany the principal migrant, providing an instrument to address the second selectivity issue. Using this natural experiment we examine the myriad impacts that migration has on remaining household members, focussing on labor supply, income, durable assets, financial service usage, diet and physical and mental health and use multiple hypothesis testing procedures to examine which impacts are robust. We find the overall impact on households left behind to be largely negative. We also find evidence that both sources of selectivity matter, leading studies which fail to adequately address them to misrepresent the impact of migration.

**Keywords**: Emigration, Natural Experiment, Selectivity, Wellbeing, Remittances.

**JEL Classification:** J61, F22, C21.

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## 1. Introduction

The impacts of international migration on development in the sending countries, and especially the effects on remaining household members, are increasingly studied. Empirical analysis is needed because the effect of migration on development in source communities is *a priori* unclear. Migrant-sending households and their communities can benefit from remittance inflows, which now make up 30 percent of total financial flows to the developing world, but earnings and other household inputs that migrants would have generated locally are lost. Hence this is a growing area of the literature; for example, out of the 392 journal articles and working papers with remittances as a title or keyword, 60% were published since 2006.[1] Even more studies are likely in future as new survey data become available and labor mobility increases in response to growing international wage gaps, rising demand for services, divergent trends in youth and elderly populations in developed and developing countries, and catch up from the previously "everything but labor" nature of globalisation in the post-World War II era (Pritchett, 2006).

The biggest difficulty in measuring impacts of migration on development is posed by selectivity issues. A common research strategy in this literature is to use household survey data to compare households who have had at least one member emigrate to those that have not. Such comparisons are complicated by a double-selectivity problem: first, households self-select into migration, and second, among households involved in migration, some send a subset of members with the rest remaining whilst other households migrate en masse.

In this paper we address these selectivity issues using the randomization provided by an immigration ballot under New Zealand's immigration policy. We survey applicants to this random ballot and compare outcomes for the remaining household members of emigrants with those for members of similar households who were unsuccessful in the ballot. The policy rules determine which household members can accompany the principal migrant, providing an instrument to address the second selectivity issue. Since this migration channel has only recently opened, we measure the short-term impact of migration, which may change over time. The short term may be when household challenges are greatest, as they adapt to the absence of household members and have yet to receive large quantities of remittances.

The particular policy we focus on is the Pacific Access Category (PAC), which was established in 2001 and allows an annual quota of 250 Tongans to immigrate as permanent residents to New Zealand without going through the usual channels used for groups such as

[1] Specifically, a search of EconPapers on RePEC (January 27, 2009) reveals that there were 17 papers in all of the 1980s, 49 in all of the 1990s, 88 between 2000 and 2005, and 87 in 2008 alone.

skilled migrants and business investors. Many more people apply than the quota allows, so a ballot is used by the New Zealand Department of Labour (DoL) to randomly select from amongst the applicants. The probability of success in the ballot is approximately ten percent. We evaluate the impact of individuals migrating to New Zealand via the PAC on household members remaining in Tonga (mainly parents, siblings, and nephews and nieces of the migrant applicant). We consider a wide range of impacts, including the impact on labor supply, income, durable assets, financial service usage, diet and physical and mental health.[2]

Our results suggest that at least in the short run there may be some adverse consequences for those left behind when a subset of their household migrate to New Zealand. Income falls by approximately 20-25 percent, whether measured per capita or per adult equivalent, with a rise in net remittances not offsetting a large fall in labor earnings. Ownership of livestock, durables, and access to financial services is also lower for the remaining household members than for the control group. Diets change, with less fruit, vegetables and fats consumed and more rice and root crops. Beneficial health changes include falls in the body mass index and waist to hip ratio for working age adults.

We also use data from a sample of non-applicants, and from ballot losers in households which would entirely move if they had been successful in the PAC ballot, to examine the degree of selection of households into migration, and selection among households with a migrant as to which would partially move and which would move en masse. We find selection is important in both dimensions. Thus, the non-experimental estimation of migration impacts results in a biased assessment. In particular, using a sample of non-applicant households would lead one to conclude that emigration has made remaining household members wealthier, whereas the natural experiment shows the opposite result.

These results may have broader applicability since Tongan migrants to New Zealand under the PAC have characteristics that are quite typical of developing country migrants to the US, both in terms of their levels of education and the degree of educational self-selection relative to non-migrants (McKenzie, Gibson and Stillman, 2009). Moreover, although a stereotype is of a husband migrating alone and leaving a family behind in a developing

[2] In an earlier paper published in a conference volume (McKenzie et al, 2007), we used the same dataset to estimate the experimental impact of migration on poverty, household size and total income. The current paper also considers household size and total income as two of the 62 different outcomes considered in this paper. Despite this small overlap, the current paper differs significantly from our earlier work. In addition to looking at many more outcomes, the current paper is the first of our work (and the first in the migration literature) to explicit note the double-selectivity issue caused by migration and show the biases which this causes in non-experimental results, and the first to examine the importance of using multiple hypothesis testing for interpreting the results.

country, a majority of married developing country immigrants in the US actually have their spouse present, similar to our setting.[3] Immigration policies in many countries worldwide (e.g. Australia, Canada, Ireland, United Kingdom, France, Italy) allow individuals moving on an employment visa to bring their spouse and dependent children, but not to immediately bring their parents or adult siblings. The United States also allows for parents to accompany the migrant, but not adult children or siblings. Consequently, the impacts on household structure and on other outcomes for the families of those may be quite similar in many other migrant-sending countries to what we observe amongst the Tongans left behind when family members emigrate to New Zealand.

In the next Section we review relevant literature on the impact of emigration on source areas and discuss channels through which emigration may affect household members left behind. Section 3 provides background on the immigration program we examine, and Section 4 describes the data from the Pacific Island-New Zealand Migration Study (PINZMS) and our estimation methods. The impacts on household level outcomes are presented in Section 5 and on individual outcomes in Section 6. Section 7 discusses multiple hypothesis testing, while Section 8 concludes.

## 2. Previous Literature

### 2.1. Channels and Impacts

The most studied impact of migration on household members left behind has been the impact of remittances received. There are a variety of reasons that migrants send remittances, including altruism towards those left behind, exchange for a variety of services provided by the remaining family members (such as caring for property or other relatives), repayment of loans made to finance migration or education, and insurance and strategic motives (Rapoport and Docquier, 2006). These remittances directly contribute to household income, allowing households to purchase more assets, and buy more normal goods, including education and health inputs.[4] They can also relax liquidity constraints, enabling greater household investment in businesses and children's education, and enable households to better mitigate the impact of domestic shocks.

[3] Specifically, using the 5% public use sample of the 2000 U.S. Census, we find that 59% of married immigrants from developing countries who arrived in the U.S. in the last year had their spouses also present in the U.S. Even for Mexico, we find 46% of newly arrived married immigrants have migrated with their spouse.
[4] Remittances may also be received in the form of durable assets, directly increasing household asset stocks.

If migration purely resulted in an exogenous increase in income for the remaining household members, the sign of the expected impact on many outcomes of interest would be easily determined. However, migration can also have a number of other impacts on the sending household. Most obviously, an absent migrant earns no domestic wage and provides no time inputs into household production. These effects may counteract the effect of remittances received, so for example, households have less time to spend educating children, but perhaps more money to spend on them. Migrants may also transfer knowledge and attitudes to their remaining family members. For example, Hildebrandt and McKenzie (2005) find contraceptive knowledge to increase with emigration of household members from Mexico to the US. Absence of decision-makers may also lead to changes in the bargaining power of remaining members in the household leading to a reallocation of household spending priorities (Chen, 2006). Separation from family members may impact on mental health. Finally, migration of some family members may make it more likely that others will migrate in the future, changing the incentives to acquire education.

The result of all of these different potential channels is that the overall impact of migration on various measures of the welfare of remaining family members is theoretically uncertain. The effects are also likely to vary with the amount of time the family member is away. For example, Lucas (1987) finds emigration from Botswana, Lesotho and other Southern African countries to South Africa decreases domestic crop productivity in the short run as labor is removed from the farm, but appears to enhance crop productivity and cattle accumulation in the long run through invested remittances. Many other empirical studies are unable to control for the length of time migrants have been away, resulting in an averaging of short run and long run effects.

### 2.2. Selection and Identification

The main challenge facing empirical analysis of the impacts of migration and remittances on sending households is a double-selectivity problem. First, households choose whether to engage in migration.[5] Households which send migrants are likely to differ along a number of observable and unobservable dimensions from households which do not send

[5] To be precise, they choose whether to engage in migration given the existing policy environment. In most cases this is a policy environment which also involves substantial selection from the receiving country side with employers and government officials screening interested potential migrants to determine which ones can actually move. Since there is less screening at destination in our case than in the case of much legal migration, the degree of self-selection is likely to be less in our example than in cases where employers and governments are also involved in selecting the migrants. As a result, our results will be, if anything, conservative in terms of showing the potential bias from self-selection.

migrants, with some of these characteristics likely correlated with outcomes of interest. For example, an unobserved asset shock may make the sending household poorer and encourage emigration. Households with aptitude and knowledge of foreign languages may be more inclined to engage in migration, and also have children who do better in school. Second, amongst households which decide to engage in migration, some decide to move with their entire families, while in others only some members emigrate.[6] A third form of selection which also occurs in many contexts is selection into which migrants return. Since we are examining the short-run impacts of migration, this source of selectivity is not an issue here.[7]

We are not aware of any study of the impact of migration on sending households which explicitly deals with the second form of selection, since almost all developing country migrant datasets lack information on entire households that move. The literature has used a variety of approaches to address the first form of selection. Examples include assuming selection on observables (e.g. Adams, 1998; Cox-Edwards and Ureta, 2003), parametric selection correction models (e.g. Barham and Boucher, 1998; Acosta, Fajnzylber and Lopez, 2007), propensity-score matching (Esquivel and Huerta-Pineda, 2006), instrumental variables methods, predominantly using current migration networks (e.g. Mansuri, 2006, Brown and Leeves, 2007) or historic networks as instruments (e.g. Woodruff and Zenteno, 2007; McKenzie and Rapoport 2007)[8] and work by Yang (2008) which uses a natural experiment provided by exchange rate shocks in destination countries to look at impacts within the group of households with migrants abroad.

However, one may question the identification assumptions underlying these non-experimental approaches to constructing no-migration counterfactuals. There is evidence that migrants self-select both in terms of observables and unobservables (McKenzie, Gibson and Stillman, 2009, Akee, 2009), so methods that assume selection on observables (which include OLS and matching) are likely to be biased. Selection correction methods rely on parametric structure and dubious excludability assumptions. For example, Acosta et al. (2007) and Barham and Boucher (1998) assume that household asset holdings predict selection into migration but do not directly affect earnings or labor force participation, when these assets

[6] A further issue faced by some of the literature is the attempt to distinguish the impact of remittances from the overall impact of migration. See McKenzie (2005) for a critique of this approach.

[7] None of the PAC migrants had returned to live in Tonga during the period of our study.

[8] Other instrumental variables have been also been used, but the exclusion restriction underlying these are perhaps less convincing than the historic network variables. For example, Amuedo-Dorantes and Pozo (2006a) assume that the number of Western Union branches in a state in Mexico affects labor supply only through current migration, when these branches are likely to have been established as the result of factors which have driven migration historically, including the level of development in a state, which likely also impact on labor supply.

could be used to help finance own businesses, or could be the result of labor earnings. The use of current migration networks as an instrument is subject to concerns about other variables at the community level which also affect migration and outcomes of interest. For example, a recent community weather shock such as a drought may have led to both increased migration and a reduction in agricultural income in the community. Historic networks are less subject to concerns about recent shocks, but still need to rely on a plausible story of why networks exogenously formed in one location and not in another, such as the pattern of development of the railroad system in Mexico, as used by Woodruff and Zenteno (2007). The natural experiment utilized by Yang (2008) provides the cleanest identification of the impact of changes in remittance receipts amongst households receiving remittances, but is unable to address the impacts of other channels through which migration can affect households.

### 2.3. On Which Household Outcomes Does the Literature Focus?

The growing literature on the impact of migration and remittances has examined a variety of outcomes, all intended to measure the extent to which migration can aid "development" in the sending countries. However, each study typically focuses on the impact of migration on only a small number (often one) of outcomes in the sending country, preventing analysis of the full range of impacts of migration on households in any one sending country. Common outcomes of interest include income and poverty levels, employment and business ownership, child health and education, and asset ownership. These outcomes are both of inherent interest, and also the most commonly available measures in household surveys.

Existing evidence paints a generally rosy picture of the impact of migration on the incomes, asset holdings, and poverty levels of household members left behind (Adams, 2007 provides a recent review). These studies generally attempt to construct a no-migration or no-remittance counterfactual by estimating what the income of the household would be without remittances but with the migrant working in the home country (e.g. Barham and Boucher, 1998; Adams, 2006). In earlier work (McKenzie, Gibson and Stillman, 2007) using the same dataset as this paper, we compare the experimental outcome of migration on per-capita income and poverty to what would be predicted using such methods. We find that when these counterfactual earnings are estimated using the unsuccessful lottery applicants the results are similar to the pure experimental estimates. However, when non-applicants are used to estimate counterfactual earnings the estimated earnings are much lower, leading to a spurious

finding of migration lowering poverty. This leads us to cast some doubt on the positive impacts of migration on poverty and income seen in earlier studies which are unable to use a suitable comparison group of non-migrants.

Amongst the fewer studies of the impact on child health outcomes, all show positive effects, although more mixed results on inputs. For example, Hildebrandt and McKenzie (2005) find lower infant mortality rates and higher birth weights amongst Mexican migrant-sending families, but also that children in migrant households are less likely to be breastfed or be vaccinated. Acosta et al. (2007) find higher weight-for-age and height-for-age among children in migrant families in Nicaragua and Guatemala.

The existing literature finds ambiguous effects of migration on several other key outcomes of interest. In terms of the effect on child education, Cox-Edwards and Ureta (2003) find that migration increases school attendance rates in El Salvador, and Yang (2008) finds that increased remittances lead to more schooling in the Philippines, both consistent with higher income alleviating liquidity constraints, whereas McKenzie and Rapoport (2006) find migration lowers schooling attainment in Mexico, with boys in migrant households more likely to drop out of school to migrate, and girls undertaking more housework.

Evidence is also mixed in terms of the impact on adult employment. Funkhouser (1992) finds remittances to be associated with lower overall labor supply, but higher self-employment in Nicaragua. Acosta (2006) finds a negative impact on female labor supply in El Salvador, but no effect on male labor supply. Yang (2008) finds higher remittances lead to households being more likely to engage in entrepreneurial activities and to spend more hours in self-employment, but to no significant effect on overall labor supply. Amuedo-Dorantes and Pozo (2006a) find remittance receipt lowers female labor supply in Mexico, and shifts male labor supply from formal to informal sector work. Woodruff and Zenteno (2007) find remittance receipt to significantly increase the amount of capital invested in microenterprises in Mexico, whereas Amuedo-Dorantes and Pozo (2006b) find a significant negative impact of remittances on business ownership in the Dominican Republic.

In this paper, we will consider these outcomes, along with other welfare outcomes such as diet, anthropometric health measures, and mental health, which are measured less often in household surveys and for which we have not been able to identify existing literature. For example, a recent submission to the Global Commission on International Migration states (Carballo and Mboup, 2005, p. 5) that “for close family and relatives left behind, the departure of migrants to seek a living elsewhere is also fraught with psychosocial difficulties”, but provides no evidence for this assertion.

In addition, Aggarwal et al. (2006) have recently used cross-country panel data to show an association between remittances and financial development, with the argument being that the receipt of remittances paves the way for recipients to demand and gain access to other financial services, even if the funds themselves are not received through banks. However, they note that remittances may instead substitute for use of credit and other demands for bank accounts, so that the direction of causation is unclear. Furthermore, it is possible that household members who use the banking system are more likely to migrate, reducing household use of bank accounts when they leave. We will therefore also consider measures of access to bank accounts as another outcome measure.

## 3. Context and the Pacific Access Category

### 3.1 Background

The Kingdom of Tonga is an archipelago of islands in the South Pacific, a three hour plane flight from New Zealand. The population is just over 100,000, with a GDP per capita of approximately US$2,200 in PPP terms. One-third of the labor force is in agriculture and fishing, with the majority of paid workers in the manufacturing and services sectors, which are dominated by the public sector and tourism.

Emigration levels are high, with 30,000 Tongans living abroad, 94% of them in New Zealand, Australia and the United States. Migration to New Zealand began in sizeable numbers during the 1960s and 1970s, with Tongans arriving on temporary permits to take up work opportunities. After their permits expired, some returned to Tonga and others stayed on in New Zealand illegally. An amnesty in 1976 granted many of these individuals permanent residence. Migration for work continued in the late 1970s and 1980s. However, in 1991, New Zealand introduced a selection system for immigration, in which potential migrants are awarded points for education, skills, and business capital. Few Tongans qualified to migrate under this system, and so most Tongan migration since this time has been under family-sponsored categories. For example, in 2004/05 only 20 Tongans were admitted as principal applicants under the points system, compared to 349 under family categories, the majority through marriage or as dependent children. Migration to Australia and the United States has also become much more restrictive and reliant on family reunification categories. Australia admitted 284 Tongans during the 2004/05 financial year. The United States admitted 324 Tongans in the 2004 calendar year, comprising only 5 under employment-based preferences and 290 under immediate relative or family-sponsored categories.

### 3.2. The Pacific Access Category

In 2002, another channel was opened up for immigration to New Zealand through the creation of the Pacific Access Category (PAC), which allows for a quota of 250 Tongans to emigrate to New Zealand each year without going through the usual migration categories used for groups such as skilled migrants and business investors.[9] Specifically, any Tongan citizens aged between 18 and 45, who meet certain English, health and character requirements,[10] can register to migrate to New Zealand. Many more applications are received than the quota allows, so a random ballot is used by the New Zealand Department of Labour (DoL) to draw from amongst the registrations. The odds of having one's name drawn were approximately one in ten during the period we study.

Once their ballot is selected, applicants must provide a valid job offer in New Zealand (unskilled jobs suffice) within six months in order to have their application to migrate approved. After a job offer is filed along with their residence application, it typically takes three to nine months for an applicant to receive a decision. Once receiving approval, they are then given up to one year to move. The median migrant in our sample moved within one month of receiving their residence approval.

The person who registers for the PAC is a Principal Applicant. If they are successful, their immediate family (spouse and dependent children up to age 24) can also apply to migrate as Secondary Applicants. The quota of 250 applies to the total of Primary and Secondary Applicants, and represents about 80 migrant households. Successful applicants cannot take other members of their household to New Zealand, so anyone living with parents, siblings, or other relatives will leave household members behind when they migrate.

These two features of the PAC, random selection amongst applicants and a rule specifying which family members can and cannot accompany the successful migrant, allow us to address the double-selectivity issues involved in assessing the impact of migration on the remaining household. In particular, we can compare the group of households in Tonga with a PAC emigrant to the group of unsuccessful ballots who would not be eligible to move their entire household to New Zealand had their principal applicant been chosen in the ballot.

[9] The Pacific Access Category also provides quotas for 75 citizens from Kiribati, and 75 citizens from Tuvalu. A similar scheme called the Samoan Quota allows 1100 citizens of Samoa to move each year. There have been some small changes in the conditions for migration under the Pacific Access Category since the period we examine in this paper – here we describe the conditions that applied for the potential migrants studied in this paper.

[10] Data supplied by the New Zealand Department of Labour for residence decisions made between November 2002 and October 2004 reveals that out of 98 applications only 1 was rejected for failure to meet the English requirement and only 3 others were rejected for failing other requirements of the policy.

## 4. Data, Methods and Selection

### 4.1. Data

The data are from the Tongan component of the first (and to date only) wave of the Pacific Islands-New Zealand Migration Survey (PINZMS), which measures multiple impacts of migration.[11] The PINZMS survey was designed and implemented by the authors in 2005-06 to allow study of migration through the Pacific Access Category, surveying applicants in the first four years of the PAC. The survey also covered random samples of non-applicants to enable comparisons between applicants and non-applicants.

The survey includes questions on household demographics, education, labor supply, income, asset ownership and diet, self-reported health status, smoking and alcohol use, and anthropometric measurements of height and weight for all individuals, and waist and hip circumference and blood pressure for adults. It also measures mental health for individuals aged 15 and older using the Mental Health Inventory 5 (MHI-5) of Veit and Ware (1983).

In a perfect randomised experiment, the impact of the treatment (here, having some household members emigrate) could then be obtained via a simple comparison of means in these two groups. However, mean comparisons may be biased if control group members substitute for the treatment with a similar program or if treatment group members drop out (Heckman, et al, 2000). For example, *substitution* bias will occur if PAC applicants who are not drawn in the ballot migrate through alternative means and *dropout* bias will occur if PAC applicants whose name are drawn in the ballot fail to migrate to New Zealand. Substitution bias is not of serious concern; the low odds of winning the ballot and the limits on eligibility for other migration channels available to Tongans mean that those with the ability to migrate via other arrangements would likely have done so previously. But dropout bias is a more relevant concern because approximately 15 percent of ballot winners do not ultimately move to New Zealand.

To adjust experimental estimates for possible dropout bias we use three subsets of the PINZMS sample (see Appendix Table 1): (i) 61 households, with 283 individuals, in Tonga with some previous members now PAC migrants in New Zealand; these are the "treatment" group, (ii) 26 households, with 115 individuals, containing successful participants from the same PAC ballots who were still in Tonga; these "non-compliers" had not moved when

[11] Further details about this survey and related papers produced from these data can be found at www.pacificmigration.ac.nz.

surveyed either because their application for New Zealand residence was not approved (typically because of lack of a job offer) or was still being processed, and (iii) 124 households, with 654 individuals, containing unsuccessful participants from the same ballots who were still in Tonga; these are the "control" group and were typically selected from the same villages that the sampled PAC migrants had lived in prior to moving. The two samples of successful ballots have a much higher sampling rate than the sample of unsuccessful ballots (expansion factors of approximately 3.4, 2.5 and 37.9 are needed to weight each sample up to the relevant population) and all of the analyses take this into account.

Finally we also use a fourth sample to examine selection into migration, and to carry out non-experimental estimation of the impacts of migration. This sample consists of 124 households, with 727 individuals, where no member of the household applied for the PAC. These households were randomly chosen from the same villages as the PAC households, and administered the same questionnaire.

At the time of our survey, the sampled Tongan households with PAC emigrants in New Zealand had a mean (median) time abroad for their former household members of 10 months (8 months). Just over three-quarters (77 percent) of migrant-sending households were interviewed less than one year after eligible household members had emigrated to New Zealand. Thus, our analysis is examining the initial impact of sending emigrants. The use of a homogeneous period of time abroad allows us to avoid averaging short and long run effects which may differ in sign (as found in Lucas, 1987).

### 4.2 Movers and Stayers

We use the age and relationship rules governing which Secondary Applicants can move with the Principal Applicant to identify household members that would have moved to New Zealand if the Principal Applicant had been successful and compliant with the treatment. These rules appear to be the binding constraint since the remaining family of PAC emigrants are almost all outside the age and relationship eligibility for moving to New Zealand (see Appendix Table 1).[12] Since the treatment group with migrants does not have cases where the whole household moved, neither should the control group or non-complier group. We therefore drop 75 unsuccessful households and 18 non-complier households in

[12] Specifically, just 11 (of the 283 residents of treatment group households) eligible family members stayed in Tonga rather than immediately move to New Zealand with their principal applicant. Those that did were mainly very young children and their mothers who eventually moved after our survey, when the children were at a more suitable age for travel.

which their age and relationship structure would have allowed all members to move to New Zealand.. Note that 60 percent of the unsuccessful ballots fall into this category.

Individuals in these households, those who would have moved in the control group and non-complier households and the few eligible ones who did not move to New Zealand, are all dropped for the individual level analyses, so that only like individuals in the treatment, non-complier and control group are compared to each other. We define "stayers" to be the individuals who the legal rules would require to stay behind if their principal applicant had been successful in the PAC ballot.

The remaining household members of PAC emigrants typically contain working age adults who are either the parent and/or the siblings of the Principal Applicant, along with children who are often their nephews and nieces (Appendix Table 1). Specifically, 46 percent of migrant households contain a parent of the Principal Applicant, and 52 percent have a sibling. Just over one-half (57 percent) of other relatives are under 18, and are mostly nephews and nieces of the Principal Applicant. Very few of these extended family members appear to have joined the household since the emigrants left,[13] and so as original household members their welfare is likely to have been impacted by the departure of the PAC emigrants.

As we have noted in the introduction, these remaining household members are likely to be similar to the household members remaining in many countries when migrants move to developed countries through employment categories. With the exception of the United States, all traditional immigrant receiving countries restrict the relatives that can accompany a migrant to the spouse and dependent children – the U.S. also allows parents. While in some cases emigrants can later sponsor their parents or siblings, they can not do this until they have spent several years in the country, and even then there can be restrictions or long waiting periods.[14] Thus in the short-run, the remaining family of migrants is likely to be anyone apart from their spouse and dependent children.

### 4.3. Verifying Randomization

[13] We ask about how many of the previous 12 months each person was attached to the household. The number of recent members who had been attached for less than 12 months was slightly lower (0.48 versus 0.63) for migrant families than for those with unsuccessful ballots. We do not know for all households who was attached to the household at the time the ballot result was announced since this is outside the 12 month window for many of the households. However, given the low turnover in household composition, this does not appear to be a concern.

[14] For example, several countries employ a "gravity" principle which only allows parents to be sponsored if they have no remaining children in the home country, and then impose income requirements on the sponsoring migrant. In general parents are still easier to sponsor than siblings.

We first test whether the PAC ballot correctly randomises "stayer" households into a treatment and a control group by examining whether the stayer group within the households containing ballot losers are statistically different than the stayer group in households containing ballot winners (both the migrant families and the non-compliers). The results in Table 1 show that most ex-ante pre-migration characteristics are the same for ballot winners and losers (at 95 percent confidence level). The only exceptions are that stayer adults in successful ballot households have higher education levels and that there are more children amongst the stayer group in successful ballot households. We present all regression results with and without controls for the characteristics of these stayer members to examine the robustness of our findings to small sample differences in the treatment and control group.

### 4.4. Calculating Experimental Estimates

Throughout the remainder of the paper, when we present experimental estimates of the impact on households and individuals of having household members move to New Zealand under the PAC, we do not directly compare means of the treatment and control groups due to concerns about dropout bias from non-compliers. Instead, instrumental variables regression (IV) models, where ballot success is used as an instrument for having co-residents emigrate, are used to estimate the treatment effect on the treated.[15] The PAC ballot outcome can be used as an excluded instrument because randomization ensures that success in the ballot is uncorrelated with unobserved individual attributes which might also affect outcomes among the stayer household members and success in the ballot is strongly correlated with migration.

### 4.5. Looking for Evidence of Selection

In addition to obtaining consistent estimates of the impacts of migration, one of the other goals of this paper is to examine how these estimates might change if we were unable to correctly control for the double-selectivity. Table 2 and Table 3 examine the evidence for selection in terms of the household and individual outcomes of interest, respectively. As we have noted, the appropriate comparison group for the remaining individuals in migrant

[15] While an IV regression usually estimates the local average treatment effect (LATE), Angrist (2004) demonstrates that in situations where no individuals assigned to the control group receive the treatment (i.e., there is no substitution) the IV-LATE is the same as the average treatment effect on the treated. We focus on the average treatment effect since this is the parameter we can cleanly identify and which gives the overall impact of migration. With a larger sample, we could examine the average treatment effect for subgroups of households, such as those from poorer backgrounds, or single vs married applicants, or those with different household compositions. We see such analysis of the heterogeneity of migrations' impacts as a fertile area for future studies should other migration lottery data be able to be collected.

households are the group of individuals residing in ballot loser households who would remain in Tonga even if the principal applicant from their household had been successful in the PAC ballot.[16] That is, the right comparison group for the parents, siblings nephews, and nieces of a migrant are the individuals who are the parents, siblings, nephews, and nieces of the would-be migrant in ballot loser households. Means of the outcomes of interest for this group are presented in the first column of Tables 2 and 3.

The second column of Table 2 then presents means for ballot loser households where everyone in the household would be eligible to move if the household had been successful in the ballot. We call these households "all move" ballot losers. A comparison of columns 1 and 2 then enables us to examine the evidence for selection among migrant households in terms of which migrants take their whole household and which do not. Likewise, column 2 of Table 3 presents means for adults and children who would be eligible to move if the principal applicant in their household was successful in the PAC ballot. We see definite signs of selectivity. Not surprisingly, whole households which move are smaller than households in which some individuals would stay. Failure to remove these "all move" households from the ballot losers will therefore bias estimates of the impact of migration on household size, since these smaller "all move" households are gone from the ballot winner sample, but still present in the ballot loser sample.

We also see other areas where this form of selection is important: "all move" households have fewer farm animals, are less likely to own an ATM card, and have a diet with less fruit and vegetables than stayer households. However, the only area where selection appears important in terms of individual characteristics is mental health, where the individuals which are eligible to move have worse mental health than those who are not eligible to migrate if someone in their household is successful in the PAC ballot.

The third column in Tables 2 and 3 present the means for "stayer" households and individuals in the sample of non-applicants. Comparing this column to the first allows us to examine the other channel of selection – selection into migration. We see that stayers in households where someone has applied to migrate are from larger, richer households than stayers in non-applicant households. Adults in these households are less likely to be studying than stayer adults in ballot loser households, and their children have fewer years of education.

[16] This is after adjusting for imperfect compliance by instrumenting migration with ballot success. The same discussion as is applied here to ballot loser households applies equally to non-complier households among ballot winners.

All these results are consistent with positive selection into migration.[17] Finally, the fourth column of Tables 2 and 3 includes all non-applicants, thereby combining the two forms of selectivity bias – selection into a migrant household, and selection among migrant households as to who moves. However, since only 14 percent of non-applicant households are classified as all movers, the overall effect of the two sources of selectivity is similar to that found for the impact of selection into migration on its own.

### 4.6. Calculating Non-Experimental Estimates of the Impact of Migration

Our experimental estimates of the impacts of migration come from IV regressions for the group of individuals that the PAC policy rules identify as stayers, with the migration ballot outcome used as an instrument for migration. We also estimate three other regression specifications which we use to illustrate the bias caused when the two channels of selection are ignored. First, we again estimate IV regressions, but do not use the PAC rules to eliminate ballot loser households and individuals who would have moved if the principal applicant had had a winning ballot in the PAC lottery. Comparing these estimates to the experimental estimates illustrates the impact of selection among migrant households as to whom in the household moves.

Next, we use OLS regressions to estimate the impact of migration by comparing migrant stayer households to non-applicant households.[18] In our second comparison specification, we compare migrant stayer households to only the "stayer" non-applicant households. This directly isolates the bias caused by household selection into migration. Then, in our third comparison specification, we examine the combined bias from both sources of selection by comparing migrant stayer households to non-applicant households.

In all non-experimental regressions which examine household level impacts, we condition on location (in Tongatapu or not), the maximum education level in the household, and the household's labor income earnings in 2004 (the year before the survey). For individual impacts, we condition on the same covariates as used in the experimental estimates with controls: location, gender, age, and other basic characteristics which vary for adults and

[17] This positive selection may arise from a combination of the cost of migrating, the provisions in the PAC which require a basic level of English literacy and the individual to be able to find a job in New Zealand, and also from higher inequality in New Zealand than in Tonga offering greater opportunities for the educated and skilled to increase their incomes than for the less skilled.

[18] Alternatively one could consider comparing migrant stayer households to a random sample of the population of households without migrants, which would consist of non-applicant households, ballot loser households, and non-complier households. However, since the majority of this population is, in fact, non-applicant households, the results would be similar for this full population, and we believe it to be clearer for examining selection to focus solely on a comparison to non-applicant households.

children (see tables for details). Our results are qualitatively robust to controlling for a variety of other covariates, but given the relatively small sample sizes, we cannot include a huge number of control variables at the same time.

## 5. Impacts on Household Level Outcomes

We now turn to estimating the impact of emigration on remaining household members. A limitation of this analysis is that our surveys do not provide detail on how resources are allocated within households. While this means some caution must be had in interpreting the results, it is entirely in keeping with the existing literature, which has also not been able to look at within household allocation.[19] Moreover, the comparison of experimental and non-experimental methods will not depend on this limitation.

### 5.1. Household Size and Composition

We begin by examining the impact of emigration on household size and composition, since one immediate effect is that there are "fewer mouths to feed". The impact of having some household members migrate to New Zealand on household size and composition is shown in Table 4. Emigration leads to a significant reduction in household size. The mean household has 6.7 people, and emigration is estimated to reduce this by 2.2 people. Emigration leads to households having, on average, 1.5 fewer prime-age adults and 0.7-0.8 fewer children. There is no change in the number of older adults (>45 years), which is reassuring since they are not eligible to move as Secondary Applicants.

Table 2 showed that whole households which move are smaller than stayer households. Failure to remove "all move" ballot losers would therefore cause us to understate the fall in household size from migration.[20] Similarly, households which apply to migrate are larger than those which do not. Thus, panel 3 shows that all the non-experimental estimates, which ignore this selectivity, therefore understate the fall in household size arising from migration. Instead of correctly estimating a fall of 2.2 people, we now find that household size decreased by only 0.6 to 0.8 people, and is insignificant for two of the three non-experimental estimates. The non-experimental estimates also incorrectly indicate that migration led to a statistically significant rise in the number of adults aged over 45.

[19] The only paper we are aware of which collects data on within household allocation and migration is de Vreyer et al. (2008) who consider large polygamous households in Senegal and look at allocation within subunits of the household.

[20] For household level impacts, the first set of non-experimental estimates do not include any controls. They are thus directly comparable to the estimates in Panel A in each Table examining household impacts. The reason for not including controls in these regressions is that the household level controls are defined in terms of stayer characteristics, and are thus not defined for all move households.

### 5.2. Household Income

We next examine the impact on total household income, which can be disaggregated into four sources, i) household earnings (annualised from individual reports for the previous week), ii) net returns from sales of fish, crops, livestock, tapa cloth and mats (annualised from household reports on an average month), iii) the imputed value of own-produced or own-captured food consumed by the household (annualised from household reports for the previous week), and iv) net remittances of money and goods.

Since households in Tonga who have had some members move to New Zealand under the PAC have fewer members, we examine the impact on per capita incomes and alternatively on adult equivalent incomes.[21] The results in Table 5 for log total income indicate that the families of migrants have 22-23% lower incomes than the families of non-migrants, when no control variables are included regardless of whether income is per capita or per adult equivalent.[22] The estimated impact is a 20-21% decline in income when control variables are added, but the per capita estimate is no longer statistically significant. If we instead estimate a linear model, which is more sensitive to outliers, we find that income declines by $1,000 per capita or $1,250 per adult equivalent (19-20% of the mean for treatment group households) for families of migrants when there are no controls and by $635 per capita or $910 per adult equivalent (12-14%) when controls are included; in neither case are the estimates significantly different from zero.

Examining the four components of household income, we find that having household members migrate to New Zealand under the PAC leads to significant reductions in household labour income per capita ($1,030-$1,280) or per adult equivalent ($1,260-$1,560). This is the main opportunity cost to the household of sending a migrant – the income the individual would have earned had they not migrated. These falls are partially offset by significant increases in remittances received of $465-$500 per capita or $560-$590 per adult equivalent. There is no significant change in either agricultural or subsistence income per person.[23] Thus, while households with PAC migrants receive more remittances and have fewer mouths to

[21] Nutrition-based equivalence scales are not available for Tonga. We therefore follow Deaton and Paxson (1994) and define the number of adult equivalents as the number of adults 18 and over, plus 0.5 times the number of children 17 and under. As households in Tonga who have had some members move to New Zealand under the PAC have fewer children, equivalence scales which are based on children needing less food and other resources than adults will raise per-person resources more for the control group than for the migrant group.

[22] Percent changes are calculated as $100\times[\exp(-0.259) - 1]$ and $100\times[\exp(-0.253) - 1]$.

[23] It is worth nothing that both overall agriculture and subsistence income decline significantly for households with PAC migrants, but the decline in the number of individuals in these households offsets these declines at least using per capita and per adult equivalent measures of household income.

feed, this does not compensate for the large reduction in labor earnings faced by these households.

Table 2 showed little selection between stayer and "all move" ballot loser households in terms of income variables. As a result, the first non-experimental specification (which uses all ballot losers, including "all move" households) produces results similar to the experimental results in Panel A. In contrast, Table 2 indicated significant positive selection on income in terms of being an applicant household. Thus, the non-experimental estimates in Table 5 that use the non-applicant sample understate the fall in income from migration. In fact, the point estimates here indicate that migration leads to a 15 to 18 percent increase in total income per capita for the remaining household members rather than the correct finding of a 22 to 25 percent *fall* that the experimental estimate yields. Essentially, non-applicant households are substantially poorer than migrant households would be (even conditional on prior labor earnings), and thus using them as a control group causes one to think that migrant households are relatively well off. Similarly, the use of these non-experimental control groups cause one to miss the fall in household labor earnings per capita that comes with household members migrating.

### 5.3. Durable Assets and Financial Access

We next examine changes in other measures of household resources, including three types of durable assets; i) the dwelling, ii) durable goods, and iii) livestock. We also examine the impact on the financial access of each household, in particular, whether any household members have bank accounts or ATM cards.[24]

Among our survey questions, we ask whether the dwelling is owned by anyone in the household and whether, in the last 12 months, any renovations have been done. Our survey also asks whether household members own any of 24 durable assets, including household appliances, entertainment equipment and motor vehicles. We aggregate these responses into a single index using the prices of durable goods we collected from stores in Tonga.[25] A separate question is asked on the number of automobiles that household members have available for their regular use. The final asset questions concern holdings of domestic livestock (pigs, chicken, cattle, goats and horses). We examine the impact of having

[24] An ATM card allows access to a remittance channel with transactions costs ten percentage points lower than the usual money transfer fees in the New Zealand to Tonga corridor (Gibson, McKenzie and Rohorua, 2006).
[25] We also used principal component analysis to create a single dimensional index of wealth based on the first principal component and found similar results.

household members emigrate to New Zealand on the value of durables, the number of cars, and the holdings of the main livestock; pigs, chickens and cattle.

Table 6 reports the estimated impact of having household members migrate to New Zealand on each of these outcomes. Again, impacts are estimated both without any control variables and with controls to deal with small sample differences between treatment and control groups. Although some outcomes are discrete, we continue to present estimates from linear instrumental variable regression models. We also estimated treatment effects for the discrete outcomes using the equivalent simultaneous equations probit models and found nearly identical marginal effects as those presented for the models with no covariates, but had difficulty getting the models with control variables to converge (a small number of covariates perfectly predict whether households are in the non-complier group).

We find that having household members migrate to New Zealand leads to the remaining members having fewer cars and livestock and being less likely to have a bank account or ATM card. When control variables are added, these effects persist for chickens and the financial access variables. The impacts are large, with the remaining family of emigrants having half as many chickens as non-migrant households and being 17% less likely to have a bank account and 31-34% less likely to have an ATM card. We also find negative, albeit insignificant, impacts on home ownership, the likelihood of having renovations, and the value of durable goods.

It is worth emphasising that all of these results merely reflect changes in household level assets and/or financial access. These changes may be occurring for a number of reasons: i) households may have sold-off assets so the proceeds could used by the individuals moving to New Zealand; ii) the lower incomes caused by having these family members move to New Zealand may have caused a reduction in assets and financial access relative to unsuccessful stayer households; iii) the individual in the household who used a bank account may have been the person who migrated, or iv) the change in household composition (eg the moving away of working-age household members) reduces needs for particular assets (such as cars and computers) or financial access. Only 10 percent of migrant households in New Zealand with family members remaining in Tonga report selling livestock, vehicles or other assets before moving to New Zealand, suggesting that the first explanation is not the main channel.

We saw in Table 2 that stayer ballot losers tend to be wealthier than non-applicant households, and in some dimensions, also hold more assets than entire households which move. The non-experimental estimates at the bottom of Table 6 reflect the consequences of this selection. Using the non-applicant sample, one would conclude that migration has made

remaining household members wealthier, with a higher value of durable assets, more cars, greater home ownership, and increased likelihood of having a bank account. All of these results just reflect selection, and if anything, our experimental results indicate that migration of some household members has reduced the wealth of those left behind.

**5.4 Diet**

We next examine the impact of having some household members emigrate to New Zealand on the diet of those who stay. Specifically, we ask about the number of meals at which each of thirty different foods were eaten at by any household resident the previous day. To focus our analysis, we examine the cumulative number of meals in which seven foods are consumed, six of which are composites. These foods are: rice, roots, fruits and non-root vegetables, fish, fats, meats and milk.

The results presented in Table 7 indicate that having family members emigrate leads to a significant increase in the consumption of rice and roots and a significant decrease in the consumption of fruits and vegetables. These changes in diet are large; consumption of rice doubles, consumption of roots goes up by 20-25%, and consumption of fruits and vegetables declines by 38-40%.

The question on diet asks which foods anyone in the household ate yesterday. We would thus expect larger households to be more likely to have someone eating any given food group. Since this question is asked of the entire household, and not just of the members who would stay if the household had a PAC ballot winner, the smaller size of migrant households should lead to a tendency to find lower likelihoods of consuming any particular food group. The significant negative result for fruits and vegetables may therefore just reflect that migrant households do not have as many prime age adults who are likely to eat these foods. However, this mechanical effect of household size cannot explain the increase in rice and root consumption amongst migrant households.

The main selectivity in terms of diet is on rice, roots, and fruits and vegetables. Consistent with stayer ballot loser households being wealthier, they have a diet richer in more expensive fruits and vegetables, and eat less rice and roots, which are cheap sources of calories. As a consequence of this selectivity, failure to exclude whole households which would have moved or using the non-applicant sample leads one to understate the fall in fruits and vegetables, and the rise in root and rice consumption. This parallels the understatement of the fall in wealth and income seen in the previous subsections.

## 6. Impacts on Individuals

Comparison of household level outcomes for migrant and non-migrant families is complicated by the issue of how to account for differences in household size. Furthermore, a unitary household model may not necessarily apply to a large household with siblings or parents living with the potential migrant. For example, while we find non-migrant households to be more likely to have a car, it is possible that the car is used only by the potential migrant, and that stayer members of this non-migrant household never use the car. We therefore turn to comparing individual level outcomes, which do not require assumptions about distribution of resources within the household.

### 6.1. Working-Age Adults

Table 8 examines the impact of migration on the labor supply, employment activity, and health of 18 to 45 year old stayer adults – the age range eligible to apply for the PAC. Since the literature has found that the impact of migration on labor supply varies by gender we split the employment results by gender. The point estimates suggest a negative effect for females and positive impact on males, but neither is significant. There is also no significant impact on business ownership/self-employment or on whether the adult is currently studying. However, we do find that individuals are less likely to be working in agriculture, significant at the 10 percent level.

Self-assessed general health status does not change with migration of other household members. We do see significant impacts on some health behaviours and anthropometric measures. Individuals in migrant households do not change smoking behaviour, but consume significantly more alcoholic drinks per month, although the significance disappears when we add controls. The Tongan population has one of the highest levels of obesity in the world, with 60 percent of the population classified as obese (Colagiuri et al., 2002). Migration is found to reduce BMI, significant at the 10 percent level, and to reduce the waist-to-hip ratio, significant at the 5 percent level. The waist-to-hip ratio is a marker of central obesity which is more strongly associated with the risk of myocardial infarction among many ethnic groups than BMI (Yusuf et al., 2005). Reductions in BMI and waist-to-hip ratios thus represent health improvements for the remaining adults in emigrant households.[26] The point estimates also suggest lowered blood pressure, but this effect is insignificant.

[26] These health improvements have occurred along with a decline in household economic resources, suggesting that one pathway is that less food leads to less over-nutrition but behavioural change could also be a factor (e.g. more walking if migrants sold the family car). Evidence from developed countries suggests that people adopt healthier lifestyles when income declines, such as during recessions (Ruhm, 2005).

In related work (Stillman et al., 2009), we have found migration to improve the mental health of the Tongans who move to New Zealand under the PAC. The last column of Table 8 shows that their remaining family members do not receive the same improvement. The MHI-5 ranges from 5 to 25, with higher scores indicating better mental health. The point estimates thus suggest that, if anything, migration lowered the mental health of remaining family members, although this effect is insignificant.

The two individual characteristics for which evidence of selection was greatest in Table 3 were mental health and currently studying. Stayer household members in ballot loser households have better mental health than individuals who would move if the household had been successful in the ballot, and also better mental health than non-applicants. The point estimates in Panel C of Table 6 reflect this selectivity, with the results that do not control for migrant selectivity indicating that migration improves mental health of those left behind, whereas the experimental estimate suggests it lowers mental health. However, these differences are not statistically significant. The currently studying variable is an example where controlling for individual characteristics eliminates selection bias – here we are controlling for years of education, which likely corrects for much of the selectivity in whether an individual is currently studying.

### 6.2. Children

Table 9 examines the impacts of migration of other household members on the education and health of children aged 17 and under. Recall that the migrants here are typically aunts and uncles of these children,[27] and their parents are not the ones migrating. For this reason we might expect less of the potential negative effects of parental absence on education and health, and that the main channel through which migration would affect these children is through income effects. Tonga has good basic education and health services, and is ranked by the UN as high in terms of human development, with an adult literacy rate of 98.2 percent.[28] As such, liquidity constraints appear unlikely to be of large importance in determining access to schooling and health, so that changes in income may have relatively small impacts on health or education outcomes.

The results in Table 9 are consistent with this hypothesis. Migration is not found to significantly affect the likelihood of currently studying, years of education attained, Tongan literacy, or either parental-assessed or anthropometric health measures. The only marginally

[27] 72% are classified as "other relative" in terms of their relation to the principal applicant, and 23% are a sibling of the principal applicant.
[28] http://palaceoffice.gov.to/content/view/124/95/ [accessed December 18, 2007].

significant effect is greater English literacy among children in migrant households, which is an impact that is missed when the non-experimental control groups are used. Similarly, the point estimates using the non-applicant sample would lead one to think that migration is increasing years of education of children remaining in migrant households, which contrasts with the zero or negative effect found with the experimental estimates.

### 6.3. Older Adults

Finally in Table 10 we report the results of migration of household members on adults aged 46 and older. The majority of these older household members are parents of the migrant, with a mean (median) age of 60 (59) years. The point estimates suggest that both older males and females are less likely to be employed when their children migrate. The magnitudes are sizeable relative to the mean, corresponding to a halving of the employment rate. However, the results are not significant when we examine men and women separately, and are only significant at the 10 percent level when we combine males and females and do not include additional controls in the regression. The point estimates also show large negative effects on the likelihood of being a business owner, but again these are statistically insignificant.

As with younger adults, there is a tendency for older adults to be less involved in agriculture when they are in migrant households, although this difference is insignificant. Older adults are marginally less likely to view themselves as being in very good health when other household members have migrated, but we find no significant impacts on health behaviour, BMI, waist-to-hip ratios, blood pressure, or mental health.

Since, under the PAC rules, none of these older adults would be eligible to move, the only channel for selection is in terms of whether adults aged over 45 in households where someone else applies to migrate are different from adults aged over 45 in households where no one applies to migrate. There appears to be some selection in terms of mental health – older adults in non-applicant households have better mental health. This results in a negative point estimate when using the non-experimental control group, as opposed to the positive experimental point estimate, although neither estimate is statistically significant.

## 7. Omnibus Effects and Multiple Hypothesis Testing

Our analysis so far has followed the existing literature and tested for the impact of migration on particular outcomes on a one-by-one basis. An advantage of this approach is that we can directly compare our results for any particular outcome, for example, the impact of migration on business ownership, to those from other studies examining the same

outcome. However, in total over Tables 4 through 10, we are examining the impacts of migration on 62 different outcomes, and for each outcome, we consider the result with and without controls. This raises questions about multiple hypothesis testing. In this section, we examine which of our results are robust to different corrections for multiple testing.

One approach sometimes used with multiple outcomes is to aggregate them into particular groupings to examine whether the overall impact of the treatment on a family of outcomes is different from zero.[29] This is useful if the intention is to see whether the global impact of a particular treatment is generally positive. This is not our focus here, since we are interested in the individual channels through which migration impacts family members left behind. For example, we are interested in whether household labor earnings and subsistence earnings go down with migration and remittances go up, more than whether the average effect over all types of income is positive or not.

We instead consider the significance of individual coefficients when viewed as part of a family of *n* hypotheses. For example, we could consider all outcomes related to diet as a family. The family-wise error rate is then defined as the probability of at least one type I error in the family (Shaffer, 1995). Then, we can maintain the family-wise error rate at some designated level α, such as 0.05 or 0.10, by adjusting the p-values used to test each individual null hypothesis in the family. The simplest such method is the Bonferroni method, which uses as critical values α/*n*. Thus, with 10 outcomes in a family, we would need to use a cutoff of a p-value less than 0.01 when testing each individual outcome to maintain the family-wise error rate at 10 percent.

Several refinements to the Bonferroni method offer greater power.[30] Ranking the *n* outcomes in increasing order of their p-values for testing a null effect, so that $p_1 \leq p_2 \leq ... \leq p_n$. Then, the Holm's (1979) sequentially-rejective bonferroni method is applied as follows. In the first step, a null effect for outcome 1 is rejected if $p_1 \leq \alpha / n$. If we cannot reject this outcome, we cannot reject null effects for all other outcomes. Otherwise, reject a null effect for outcome 2 if $p_2 \leq \alpha/(n-1)$, and at step *j*, reject a null effect for outcome *j* if and only if null effects have been rejected for all outcomes *i*<*j*, and $p_j \leq \alpha/(n-j+1)$. Hochberg (1988) provides a "step-up" modification of this procedure, which rejects null effects for all outcomes $i \leq j$ if $p_j \leq \alpha/(n-j+1)$ for any *j=1,2,…n.*

[29] See, for example, O'Brien (1984) and Kling and Liebman (2004)
[30] The description of methods here is based on Shaffer (1995).

The disadvantages of these approaches are that the larger the number of outcomes in the family, the smaller the average power for testing each individual outcome. Furthermore, these tests are conservative, as they are based on the assumption of independence between outcomes. This is certainly not the case in our application, where most outcomes within families are very closely related to one another. We therefore follow Katz, Kling and Liebman (2007) in calculating bootstrapped estimates of adjusted p-values using a modification of the free step-down algorithm of Westfall and Young (1993).[31] This approach uses the correlation across test statistics to increase the power for testing each individual outcome.

Table 11 shows the 18 outcomes for which the experimental estimates are significant (with controls added) at the 10 percent level when examined individually. If a researcher were examining migration papers for evidence of a significant impact of migration on, say working age adult BMI, then the p-value of 0.052 is strongly suggestive that migration lowered BMI. However, if the researcher is reading our paper to see what the significant effects of migration are, one should have a lot more caution in interpreting these BMI results – they may just be the outcome observed by chance to be significant among a whole host of health outcomes that are being examined at the same time. In contrast, the adjusted p-value of 0.268 for adult BMI means that if one were to search for an effect among the 12 different working age adult outcomes in Table 8, at least one effect this large would be observed 26.8 percent of the time.

Given the loss of power involved in multiple testing and our small sample sizes, we fix the family-wise error rate at 10 percent. If we were to consider all 62 outcomes as a family, the Bonferroni p-value is thus 0.0016. The only outcomes that are significant at this level are total household size, and the number of adults aged 18 to 45. The Holm and Hochberg and Westfall-Young adjustments do not reveal any other outcomes to be significant. That is we can be very confident that migration lowers the size of the sending household, a none too startling result.

A slightly less conservative approach is to consider the outcomes in each table as a family of outcomes. The second, third, and fourth columns of Table 11 provide adjusted p-values for this family-wise comparison. Doing this again reveals that in addition to lowering household size, we can be very confident that migration raises the amount of remittances the sending household receives. After the Westfall-Young adjustments, there are five other

[31] See Appendix A of Katz et al. (2007) for a detailed description of how this is implemented.

outcomes that are marginally significant (in the 0.10 to 0.14 adjusted p-value range).[32] These are the fall in household labor earnings per capita and per adult, the decline in household ATM card ownership, the decline in adult waist-to-hip ratio, and a drop in the number of meals of fruits and vegetables eaten by the household. None of the individual level outcomes for older adults or children (Tables 9 and 10) are significant when we adjust for multiple hypothesis testing.

## 8. Conclusions

In this paper, we have made two innovations to advance the literature on estimating the impact of migration on development. First, we have used an unusual randomised migration policy along with data collected specifically to exploit the experimental variation provided by this policy to estimate the true short-run impact of migration on household members remaining in a developing country after some family members have migrated to a developed country. We have also demonstrated that both the selection of households into migration and the decision among migrant households whether to send a subset of members or to migrate en masse biases non-experimental estimates of the impact of migration on development. Second, in contrast to most studies, which examine the impact of migration on at most a few outcomes, we examined the impact on a comprehensive set of household and individual level development indicators, including income, asset ownership, labor supply, business ownership, physical and mental health, and child education.

Our results suggest that family members remaining in Tonga may initially be made worse off in several respects after some of their household members immigrate to New Zealand, and that failure to account for the double-selectivity of migration would miss most of this impact. Households sending migrants are smaller in size, and receive more remittances per capita. However, the amount received in remittances and the reduction in household size is not enough to compensate for the lost labor earnings of the migrants, leading to sizeable reductions in household income per capita. Migrant sending households also appear to have fewer durable assets and livestock, and are less likely to have access to banking services, such as ATM cards. The impacts on individual level outcomes are imprecise, with sizeable point estimates accompanied by large standard errors in many cases. Adults in migrant-

[32] Note that when the treatment tends to operate in the same direction on the different outcomes in a family, the Westfall-Young p-values are smaller than the more conservative Bonferroni and Holm p-values. However, in some of the families of outcomes examined here, there can be a negative correlation. For example, the more positive and significant is the increase in remittances from migration, the less negative (and hence less significantly negative) is the fall in total income.

sending households are less likely to be obese, although the significance of this result is not robust to corrections for multiple hypothesis testing.

Overall, our findings give a less rosy picture of the (immediate) impact of migration on the incomes and wealth of household members left behind than is provided by much of the existing literature. We show that the failure to account for both the selection of households into migration and the decision among migrant households whether to send a subset of members or to migrate en masse leads to estimates which incorrectly indicate that PAC migration has increased income and wealth among Tongan households. This result suggests that nearly all previous papers in this large literature should be viewed with some suspicion since it is nearly impossible to control for both sources of migrant self-selection in observational studies.

It is worth emphasising that we are only examining short-run impacts. While this has the advantage that we are not mixing together households with different lengths of time in the receiving country, as some papers in the literature appear to do, it is possible that the impacts will differ in the long-run. For example, there are a number of significant costs that emigrants face in moving to New Zealand, so it is possible that their remaining family in Tonga will receive greater remittances in the future, once the migrants have repaid their moving costs. However, there is no guarantee of this occurring, and, in fact, expectations questions that we ask of both migrants and their remaining family members suggest that remittances will decline over time.

Finally, it must be noted that the treatment studied in this paper is the combination of emigration and restriction on which family members can accompany the principal migrant. Other research with PINZMS data shows that those who move to New Zealand experience large gains in income (McKenzie et al., 2009) and improvements in mental health (Stillman et al., 2009). These positive impacts would likely extend to the remaining family if they were also allowed to move with the migrant. Since almost all migrant-destination countries impose age and relationship rules blocking certain family members from accompanying migrants, there may be millions of migrant-sending households in the developing world whose remaining members become worse off. The methodological comparisons in our current paper suggest that these negative impacts would be unlikely to be detected by the conventional methods and data used in previous studies of the development impact of migration.

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## Table 1: Tests of Randomization

| | Successful Ballot | Unsuccessful Ballot | T-Test P-Value |
|---|---|---|---|
| *Stayer Household Characteristics (n=118)* | | | |
| Size of the Stayer Household | 4.2 | 3.3 | 0.068 |
| Number of Adults 18-45 Among Stayers | 1.5 | 1.5 | 0.928 |
| Number of Children <18 Among Stayers | 1.6 | 0.8 | 0.005 |
| Number of Adults >45 Among Stayers | 1.1 | 1.0 | 0.726 |
| Proportion of Adults 18-45 Who Are Female | 0.53 | 0.52 | 0.949 |
| Annual Labor Earnings of Stayers in 2004 | 4,118 | 5,337 | 0.419 |
| *Characteristics of Stayer Children (n=146)* | | | |
| Proportion Female | 0.45 | 0.58 | 0.150 |
| Mean Age in Months | 91 | 114 | 0.189 |
| *Characteristics of Stayer Working-Age Adults (n=176)* | | | |
| Proportion Female | 0.53 | 0.49 | 0.578 |
| Mean Age | 29.4 | 27.5 | 0.172 |
| Mean Height | 167 | 168 | 0.693 |
| Born on Tongatapu | 0.79 | 0.68 | 0.394 |
| Mean Years of Education | 10.9 | 9.7 | 0.035 |
| Visited New Zealand Prior to 2000 | 0.14 | 0.10 | 0.388 |
| Weekly Labor Earnings in 2004 | 46 | 48 | 0.903 |
| *Characteristics of Stayer Older Adults (n=121)* | | | |
| Proportion Female | 0.57 | 0.55 | 0.777 |
| Mean Age | 61.2 | 58.5 | 0.177 |
| Mean Height | 167 | 165 | 0.750 |
| Born on Tongatapu | 0.76 | 0.72 | 0.659 |
| Mean Years of Education | 9.7 | 8.6 | 0.090 |
| Visited New Zealand Prior to 2000 | 0.40 | 0.27 | 0.141 |

Note: T-tests account for household level clustering

**Table 2: Selectivity in Household Characteristics Among Who Applies and Who Moves with Their Whole Household**

| | Sample Means | | | | P-value for T-test of Equality with Stayer Ballot Losers | | |
|---|---|---|---|---|---|---|---|
| | Stayer Ballot Losers | All Move Ballot Losers | Non-Applicant Stayer HHs | All Non-Applicant Households | All Move Ballot Losers | Non-Applicant Stayers | All Non-Applicants |
| Total Household Size | 6.65 | 4.37 | 6.04 | 5.90 | 0.000 | 0.227 | 0.128 |
| Adults Aged 18 to 45 | 3.08 | 1.84 | 2.62 | 2.55 | 0.000 | 0.085 | 0.035 |
| Children Aged Under 18 | 2.57 | 2.53 | 2.88 | 2.89 | 0.930 | 0.406 | 0.387 |
| Adults Aged over 45 | 1.00 | 0.00 | 0.50 | 0.43 | 0.000 | 0.001 | 0.000 |
| Log Total Income Per Capita | 8.36 | 8.41 | 7.93 | 8.00 | 0.784 | 0.002 | 0.007 |
| Total Income Per Capita | 5,400 | 6,508 | 3,626 | 3,896 | 0.238 | 0.001 | 0.005 |
| Household Labor Earnings Per Capita | 2,683 | 3,359 | 1,712 | 1,851 | 0.274 | 0.004 | 0.013 |
| Agricultural Income Per Capita | 282 | 141 | 124 | 113 | 0.283 | 0.126 | 0.079 |
| Subsistence Income Per Capita | 2,192 | 2,621 | 1,659 | 1,789 | 0.360 | 0.103 | 0.206 |
| Remittances Per Capita | 243 | 373 | 130 | 130 | 0.133 | 0.179 | 0.156 |
| Home Ownership | 0.53 | 0.35 | 0.29 | 0.32 | 0.043 | 0.004 | 0.011 |
| Improve Home | 0.06 | 0.01 | 0.06 | 0.05 | 0.142 | 0.899 | 0.734 |
| Value of Durables | 7,672 | 7,456 | 6,042 | 6,250 | 0.611 | 0.001 | 0.003 |
| Number of Cars | 1.24 | 1.01 | 0.83 | 0.82 | 0.047 | 0.001 | 0.000 |
| Number of Pigs | 5.96 | 4.12 | 5.36 | 5.22 | 0.010 | 0.607 | 0.495 |
| Number of Chickens | 8.49 | 3.84 | 6.28 | 6.07 | 0.001 | 0.148 | 0.097 |
| Number of Cattle | 1.71 | 0.87 | 0.71 | 0.73 | 0.042 | 0.004 | 0.003 |
| Has Bank Account | 0.89 | 0.88 | 0.64 | 0.64 | 0.792 | 0.002 | 0.002 |
| Has ATM Card | 0.76 | 0.57 | 0.44 | 0.49 | 0.034 | 0.000 | 0.001 |
| # Meals Rice | 0.08 | 0.29 | 0.23 | 0.25 | 0.004 | 0.030 | 0.016 |
| # Meals Roots | 1.57 | 1.85 | 1.81 | 1.83 | 0.022 | 0.048 | 0.029 |
| # Meals Fruits/Vegetables | 3.27 | 1.79 | 2.77 | 2.66 | 0.000 | 0.151 | 0.068 |
| # Meals Fish | 0.55 | 0.63 | 0.62 | 0.62 | 0.435 | 0.493 | 0.450 |
| # Meals Fats | 0.84 | 0.65 | 0.81 | 0.78 | 0.149 | 0.868 | 0.695 |
| # Meals Meats | 1.02 | 0.96 | 1.00 | 1.02 | 0.608 | 0.875 | 0.977 |
| # Meals Milk | 0.35 | 0.43 | 0.20 | 0.26 | 0.447 | 0.073 | 0.305 |

Note: See the paper for variable definitions.

**Table 3: Selectivity in Individual Characteristics Among Who Applies and Who Moves with Their Whole Household**

| | Sample Means | | | | P-value for T-test of Equality with Stayer Ballot Losers | | |
|---|---|---|---|---|---|---|---|
| | Stayer Ballot Losers | Mover Ballot Losers | Non-Applicant Stayers | All Non-Applicants | Mover Ballot Losers | Non-Applicant Stayers | All Non-Applicants |
| *Adults Aged 18 to 45* | | | | | | | |
| Currently Employed (Males) | 0.46 | 0.59 | 0.57 | 0.56 | 0.161 | 0.243 | 0.284 |
| Currently Employed (Females) | 0.33 | 0.47 | 0.25 | 0.28 | 0.152 | 0.308 | 0.537 |
| Business Owner | 0.10 | 0.12 | 0.13 | 0.11 | 0.666 | 0.463 | 0.679 |
| Main Activity is Agriculture | 0.30 | 0.25 | 0.26 | 0.25 | 0.436 | 0.506 | 0.343 |
| Currently Studying | 0.20 | 0.13 | 0.10 | 0.10 | 0.173 | 0.025 | 0.027 |
| Very Good Health | 0.34 | 0.36 | 0.34 | 0.34 | 0.760 | 0.974 | 0.967 |
| Currently Smokes | 0.14 | 0.21 | 0.19 | 0.18 | 0.261 | 0.374 | 0.477 |
| Alcoholic Drinks per Month | 3.3 | 9.1 | 6.6 | 6.0 | 0.203 | 0.210 | 0.269 |
| Body Mass Index | 32.4 | 34.2 | 33.0 | 33.0 | 0.136 | 0.558 | 0.577 |
| Waist-to-Hip Ratio | 0.92 | 0.92 | 0.93 | 0.93 | 0.317 | 0.668 | 0.733 |
| Diastolic Blood Pressure | 86.3 | 83.7 | 83.7 | 83.7 | 0.126 | 0.187 | 0.169 |
| Mental Health | 20.4 | 19.3 | 20.0 | 19.8 | 0.000 | 0.118 | 0.035 |
| *Children* | | | | | | | |
| English Literacy | 0.45 | 0.57 | 0.44 | 0.49 | 0.148 | 0.952 | 0.629 |
| Tongan Literacy | 0.61 | 0.64 | 0.54 | 0.59 | 0.675 | 0.454 | 0.881 |
| Currently Studying | 0.63 | 0.72 | 0.61 | 0.64 | 0.263 | 0.871 | 0.889 |
| Years of Education | 1.50 | 1.74 | 0.70 | 0.88 | 0.683 | 0.064 | 0.177 |
| Very Good Health | 0.68 | 0.52 | 0.55 | 0.54 | 0.070 | 0.143 | 0.112 |
| BMI for Age | 1.18 | 1.49 | 1.32 | 1.31 | 0.332 | 0.680 | 0.706 |
| *Adults Aged 46 and Over* | | | | | | | |
| Currently Employed (Males) | 0.36 | n.a. | 0.38 | 0.38 | n.a. | 0.938 | 0.938 |
| Currently Employed (Females) | 0.30 | n.a. | 0.28 | 0.28 | n.a. | 0.869 | 0.869 |
| Business Owner | 0.16 | n.a. | 0.19 | 0.19 | n.a. | 0.740 | 0.740 |
| Main Activity is Agriculture | 0.43 | n.a. | 0.42 | 0.42 | n.a. | 0.845 | 0.845 |
| Very Good Health | 0.37 | n.a. | 0.23 | 0.23 | n.a. | 0.121 | 0.121 |
| Currently Smokes | 0.26 | n.a. | 0.15 | 0.15 | n.a. | 0.179 | 0.179 |
| Alcoholic Drinks per Month | 3.61 | n.a. | 4.72 | 4.72 | n.a. | 0.784 | 0.784 |
| Body Mass Index | 35.6 | n.a. | 34.8 | 34.8 | n.a. | 0.770 | 0.770 |
| Waist-to-Hip Ratio | 0.92 | n.a. | 0.94 | 0.94 | n.a. | 0.153 | 0.153 |
| Diastolic Blood Pressure | 87.1 | n.a. | 90.3 | 90.3 | n.a. | 0.216 | 0.216 |
| Mental Health | 19.3 | n.a. | 20.2 | 20.2 | n.a. | 0.036 | 0.036 |

Note: T-tests account for household level clustering. n.a. denotes not applicable, since individuals aged over 45 can not be migrants under the PAC. Given this, the group of non-applicant stayers is identical to the group of all non-applicants for this age group. Mover Ballot Losers include both individuals who would move with their entire households, as well as individuals who would move when some of their members remain in Tonga.

## Table 4: Impact of Migration on Household Composition

| | Total Household Size | Adults Aged 18 to 45 | Children Aged under 18 | Adults Aged over 45 |
|---|---|---|---|---|
| *Panel A: Experimental Estimates without Controls* | | | | |
| Impact of Migration | -2.23*** | -1.54*** | -0.80* | 0.06 |
| | (0.62) | (0.33) | (0.44) | (0.18) |
| *Panel B: Experimental Estimates with Controls* | | | | |
| Impact of Migration | -2.19*** | -1.47*** | -0.68 | -0.09 |
| | (0.70) | (0.34) | (0.52) | (0.20) |
| Mean for Unsuccessful Stayer Households | 6.65 | 3.08 | 2.57 | 1.00 |
| Sample Size | 118 | 118 | 118 | 118 |
| *Panel C: Estimates using Non-Experimental Control Groups* | | | | |
| Including All Move Ballot Losers | -0.85 | -0.76*** | -0.78** | 0.64*** |
| | (0.53) | (0.23) | (0.39) | (0.15) |
| Compared to Non-Applicant Stayers | -0.72* | -0.60*** | -0.74** | 0.61*** |
| | (0.41) | (0.18) | (0.32) | (0.15) |
| Compared to All Non-Applicants | -0.64 | -0.54*** | -0.78** | 0.68*** |
| | (0.40) | (0.18) | (0.31) | (0.15) |

Note: Experimental Estimates are IV estimates where migration is instrumented with the PAC ballot outcome. Controls are labor earnings of stayers in 2004, the proportion of adult stayers who are female, highest education level of stayer adults, and whether the household lives on Tongatapu. See text for more detail on the estimates using non-experimental control groups.

*, **, and *** indicate significance at the 10%, 5% and 1% levels.

## Table 5: Impact of Migration on the Household Income of Remaining Household Members

| | Log Total Income | Total Income | Household Labor Earnings | Agricultural Income | Subsistence Income | Net Remittances |
|---|---|---|---|---|---|---|
| *Panel A: Experimental Estimates, Per Capita without Controls* | | | | | | |
| Impact of Migration | -0.259* | -1,007 | -1,281*** | -197 | 5 | 466*** |
| | (0.149) | (720) | (421) | (165) | (461) | (156) |
| *Panel B: Experimental Estimates, Per Capita with Controls* | | | | | | |
| Impact of Migration | -0.217 | -635 | -1,031** | 45 | -150 | 501*** |
| | (0.150) | (726) | (436) | (136) | (531) | (163) |
| *Panel C: Experimental Estimates, Per Adult Equivalent without Controls* | | | | | | |
| Impact of Migration | -0.253* | -1,246 | -1,556*** | -233 | -18 | 560*** |
| | (0.143) | (782) | (497) | (175) | (481) | (199) |
| *Panel D: Experimental Estimates, Per Adult Equivalent with Controls* | | | | | | |
| Impact of Migration | -0.237* | -908 | -1,257** | 25 | -266 | 589*** |
| | (0.141) | (766) | (501) | (144) | (560) | (206) |
| Mean PC for Unsuccessful Stayer Households | | 5,400 | 2,683 | 282 | 2,192 | 243 |
| Mean PAE for Unsuccessful Stayer Households | | 6,377 | 3,224 | 322 | 2,546 | 285 |
| Sample Size | 118 | 118 | 118 | 118 | 118 | 118 |
| *Panel E: Estimates using Non-Experimental Control Groups, Per Capita* | | | | | | |
| Including All Move Ballot Losers | -0.243* | -1,397* | -1,478*** | -90 | -195 | 366** |
| | (0.145) | (844) | (553) | (118) | (418) | (150) |
| Compared to Non-Applicant Stayers | 0.178 | 585 | -206 | -45 | 259 | 576*** |
| | (0.134) | (537) | (231) | (71) | (319) | (159) |
| Compared to All Non-Applicants | 0.149 | 490 | -220 | -32 | 167 | 581*** |
| | (0.129) | (529) | (225) | (69) | (313) | (156) |

Note: Experimental estimates are IV estimates where migration is instrumented with the PAC ballot outcome. Controls are labor earnings of stayers in 2004, the proportion of adult stayers who are female, highest education level of stayer adults, the number of stayers who are children and adults 18 to 45, and whether the household lives on Tongatapu. See text for non-experimental details.

*, **, and *** indicate significance at the 10%, 5% and 1% levels.

## Table 6: Impact of Migration on Durable Assets and Financial Access

| | Home Ownership | Improve Home | Value of Durables | Number of Cars | Number of Pigs | Number of Chickens | Number of Cattle | Has Bank Account | Has ATM Card |
|---|---|---|---|---|---|---|---|---|---|
| *Panel A: Experimental Estimates without Controls* | | | | | | | | | |
| Impact of Migration | -0.022 | -0.043 | -615 | -0.288* | -1.339* | -4.639*** | -0.860* | -0.172** | -0.340*** |
| | (0.103) | (0.041) | (508) | (0.153) | (0.807) | (1.711) | (0.493) | (0.078) | (0.095) |
| *Panel B: Experimental Estimates with Controls* | | | | | | | | | |
| Impact of Migration | -0.058 | -0.038 | -306 | -0.236 | -1.593 | -3.860** | -0.81 | -0.167* | -0.306*** |
| | (0.123) | (0.049) | (637) | (0.163) | (0.995) | (1.900) | (0.515) | (0.090) | (0.108) |
| Mean for Unsuccessful Stayer Households | 0.531 | 0.061 | 7,672 | 1.24 | 5.96 | 8.49 | 1.71 | 0.891 | 0.761 |
| Sample Size | 118 | 118 | 117 | 118 | 118 | 118 | 118 | 115 | 115 |
| *Panel C: Estimates using Non-Experimental Control Groups* | | | | | | | | | |
| Including All Move Ballot Losers | 0.117 | 0.018 | -328 | -0.181 | -0.207 | -2.015 | -0.438 | -0.147** | -0.219** |
| | (0.093) | (0.034) | (403) | (0.125) | (0.814) | (1.230) | (0.376) | (0.072) | (0.090) |
| Compared to Non-Applicant Stayers | 0.170** | -0.068*** | 1,150*** | 0.295** | -0.081 | -1.231 | 0.260 | 0.137* | 0.039 |
| | (0.080) | (0.024) | (388) | (0.115) | (1.155) | (1.170) | (0.277) | (0.074) | (0.080) |
| Compared to All Non-Applicants | 0.149* | -0.057*** | 1,066*** | 0.318*** | 0.054 | -1.063 | 0.263 | 0.146** | 0.002 |
| | (0.079) | (0.021) | (380) | (0.112) | (1.088) | (1.109) | (0.270) | (0.072) | (0.078) |

Note: Experimental estimates are IV estimates where migration is instrumented with the PAC ballot outcome. Controls are labor earnings of stayers in 2004, the proportion of adult stayers who are female, highest education level of stayer adults, the number of stayers who are children and adults 18 to 45, and whether the household lives on Tongatapu. See text for description of non-experimental control groups.

*, **, and *** indicate significance at the 10%, 5% and 1% levels.

## Table 7: Impact of Migration on the Diet of Remaining Household Members

| | # of Meals Rice | # of Meals Roots | # of Meals Fruits / Vegs | # of Meals Fish | # of Meals Fats | # of Meals Meats | # of Meals Milk |
|---|---|---|---|---|---|---|---|
| *Panel A: Experimental Estimates without Controls* | | | | | | | |
| Impact of Migration | 0.189** | 0.392*** | -1.291*** | 0.177 | -0.213 | -0.133 | -0.054 |
| | (0.072) | (0.142) | (0.434) | (0.111) | (0.149) | (0.137) | (0.116) |
| *Panel B: Experimental Estimates with Controls* | | | | | | | |
| Impact of Migration | 0.130 | 0.314* | -1.277** | 0.201 | -0.337* | -0.152 | 0.014 |
| | (0.087) | (0.171) | (0.498) | (0.143) | (0.180) | (0.169) | (0.118) |
| Mean for Unsuccessful Stayer Households | 0.082 | 1.571 | 3.265 | 0.551 | 0.837 | 1.020 | 0.347 |
| Sample Size | 118 | 118 | 118 | 118 | 118 | 118 | 118 |
| *Panel C: Estimates using Non-Experimental Control Groups* | | | | | | | |
| Including All Move Ballot Losers | 0.052 | 0.356** | -0.511 | 0.142 | -0.069 | -0.005 | -0.024 |
| | (0.078) | (0.144) | (0.344) | (0.092) | (0.128) | (0.122) | (0.104) |
| Compared to Non-Applicant Stayers | 0.026 | 0.135 | -0.221 | 0.145* | -0.100 | -0.129 | 0.023 |
| | (0.077) | (0.142) | (0.290) | (0.085) | (0.117) | (0.114) | (0.077) |
| Compared to All Non-Applicants | 0.010 | 0.120 | -0.136 | 0.150* | -0.080 | -0.147 | -0.019 |
| | (0.076) | (0.138) | (0.282) | (0.083) | (0.114) | (0.111) | (0.077) |

Note: Experimental estimates are IV estimates where migration is instrumented with the PAC ballot outcome. Controls are labor earnings of stayers in 2004, the proportion of adult stayers who are female, highest education level of stayer adults, the number of stayers who are children and adults 18 to 45, whether the household lives on Tongatapu, and day of the week fixed effects. Roots include taro (swamp taro), taro tanuas (chinese taro), kumara (sweet potato), taamu/kape, yams, cassava/manioc, and potato. Fruits and vegetables include other vegetables, coconut (fresh and dry), banana, mango, pawpaw, and other fruits. Fish includes tinned fish and fresh fish. Fats include corned beef, mutton, and coconut (fresh and dry). Meats include corned beef, mutton, fresh beef, chicken, pork, and other meat (eg. sausage).

*, **, and *** indicate significance at the 10%, 5% and 1% levels.

**Table 8: Impact of Migration on Outcomes for 18-45 Year-Old Adults Remaining in Tonga**

| | Currently Employed (Males) | Currently Employed (Females) | Business Owner | Main Activity is Agriculture | Currently Studying | Very Good Health | Currently Smokes | Alcoholic Drinks Per Month | Body Mass Index | Waist to Hip Ratio | Diastolic Blood Pressure | Mental Health |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Panel A: Experimental Estimates without Controls* | | | | | | | | | | | | |
| Impact of Migration | 0.084 | -0.103 | -0.001 | -0.178* | -0.085 | -0.005 | 0.009 | 7.476** | -0.565 | -0.028** | -2.686 | -0.624 |
| | (0.123) | (0.100) | (0.059) | (0.092) | (0.072) | (0.072) | (0.068) | (3.426) | (1.776) | (0.011) | (2.402) | (0.417) |
| *Panel B: Experimental Estimates with Controls* | | | | | | | | | | | | |
| Impact of Migration | 0.057 | -0.052 | 0.072 | -0.178* | 0.011 | 0.019 | 0.026 | 6.550 | -2.151* | -0.029** | -2.164 | -0.457 |
| | (0.165) | (0.093) | (0.047) | (0.098) | (0.058) | (0.099) | (0.078) | (4.268) | (1.092) | (0.012) | (2.707) | (0.556) |
| Mean for Unsuccessful Stayer Households | 0.459 | 0.333 | 0.097 | 0.300 | 0.197 | 0.338 | 0.143 | 3.31 | 32.4 | 0.925 | 86.3 | 20.4 |
| Sample Size | 85 | 91 | 175 | 170 | 174 | 171 | 135 | 134 | 157 | 159 | 144 | 172 |
| *Panel C: Estimates using Non-Experimental Control Groups* | | | | | | | | | | | | |
| Including All Move Ballot Losers | -0.038 | -0.155** | -0.044 | -0.164** | -0.059 | -0.028 | -0.057 | -1.150 | -1.803 | -0.021** | 1.958 | -0.003 |
| | (0.092) | (0.075) | (0.043) | (0.065) | (0.052) | (0.069) | (0.065) | (5.336) | (1.095) | (0.011) | (1.801) | (0.414) |
| Compared to Non-Applicant Stayer | -0.077 | -0.075 | -0.019 | -0.090 | -0.002 | -0.013 | -0.031 | 2.259 | -1.537* | -0.027*** | 0.350 | 0.169 |
| | (0.065) | (0.066) | (0.034) | (0.057) | (0.043) | (0.062) | (0.061) | (3.696) | (0.927) | (0.009) | (1.580) | (0.362) |
| Compared to All Non-Applicants | -0.037 | -0.077 | -0.003 | -0.094* | -0.013 | 0.012 | -0.008 | 3.863 | -1.398 | -0.026*** | 0.332 | 0.315 |
| | (0.064) | (0.063) | (0.032) | (0.051) | (0.041) | (0.058) | (0.056) | (3.470) | (0.852) | (0.009) | (1.362) | (0.332) |

Note: Experimental estimates are IV estimates where migration is instrumented with the PAC ballot outcome. Controls are gender, age, years of education, height, labor earnings in 2004, and whether the household lives on Tongatapu. Standard errors account for household-level clustering. See text for non-experimental description.

*, **, and *** indicate significance at the 10%, 5% and 1% levels.

## Table 9: Impact of Migration on Outcomes for Children Remaining in Tonga

| | English Literacy | Tongan Literacy | Currently Studying | Years of Education | Very Good Health | BMI for Age |
|---|---|---|---|---|---|---|
| *Panel A: Experimental Estimates without Controls* | | | | | | |
| Impact of Migration | 0.062 | -0.059 | -0.027 | 0.019 | -0.190 | 0.123 |
| | (0.123) | (0.122) | (0.111) | (0.754) | (0.141) | (0.374) |
| *Panel B: Experimental Estimates with Controls* | | | | | | |
| Impact of Migration | 0.183* | 0.015 | 0.038 | -0.466 | -0.011 | 0.164 |
| | (0.106) | (0.097) | (0.060) | (0.743) | (0.117) | (0.430) |
| Mean for Unsuccessful Stayer Households | 0.447 | 0.605 | 0.629 | 1.50 | 0.676 | 1.18 |
| Sample Size | 146 | 146 | 143 | 146 | 142 | 123 |
| *Panel C: Estimates using Non-Experimental Control Groups* | | | | | | |
| Including All Move Ballot Losers | 0.044 | 0.051 | 0.024 | -0.059 | -0.157 | -0.161 |
| | (0.080) | (0.059) | (0.047) | (0.562) | (0.100) | (0.313) |
| Compared to Non-Applicant Stayers | -0.005 | -0.041 | -0.022 | 0.463 | -0.020 | -0.049 |
| | (0.071) | (0.051) | (0.036) | (0.329) | (0.092) | (0.238) |
| Compared to All Non-Applicants | -0.023 | -0.055 | -0.028 | 0.328 | -0.020 | -0.020 |
| | (0.074) | (0.052) | (0.036) | (0.333) | (0.090) | (0.232) |

Note: Experimental estimates are IV estimates where migration is instrumented with the PAC ballot outcome. Controls are gender, age in months, age in months squared, birth order, log(household income in 2004 +1), maximum education level in household, and whether the household lives on Tongatapu. Standard errors account for household-level clustering. See text for non-experimental estimates.

*, **, and *** indicate significance at the 10%, 5% and 1% levels.

**Table 10: Impact of Migration on Outcomes for Adults Aged 46 and above in Tonga.**

| | Currently Employed (Males) | Currently Employed (Females) | Business Owner | Main Activity is Agriculture | Very Good Health | Currently Smokes | Alcoholic Drinks Per Month | Body Mass Index | Waist to Hip Ratio | Diastolic Blood Pressure | Mental Health |
|---|---|---|---|---|---|---|---|---|---|---|---|
| *Panel A: Experimental Estimates without Controls* | | | | | | | | | | | |
| Impact of Migration | -0.159 | -0.163 | -0.083 | -0.130 | -0.104 | -0.102 | 0.463 | -0.469 | 0.007 | 1.258 | 0.224 |
| | (0.129) | (0.109) | (0.069) | (0.104) | (0.093) | (0.097) | (3.838) | (3.576) | (0.012) | (3.360) | (0.484) |
| *Panel B: Experimental Estimates with Controls* | | | | | | | | | | | |
| Impact of Migration | -0.182 | -0.113 | -0.127 | -0.111 | -0.212* | -0.074 | 2.124 | 1.902 | 0.004 | -1.144 | 0.146 |
| | (0.140) | (0.156) | (0.112) | (0.125) | (0.116) | (0.128) | (3.997) | (2.073) | (0.014) | (3.561) | (0.537) |
| Mean for Unsuccessful Stayer Households | 0.364 | 0.296 | 0.163 | 0.435 | 0.367 | 0.263 | 3.61 | 35.6 | 0.918 | 87.1 | 19.3 |
| Sample Size | 53 | 68 | 121 | 117 | 121 | 85 | 85 | 105 | 104 | 104 | 120 |
| *Panel C: Estimates using Non-Experimental Control Groups* | | | | | | | | | | | |
| Compared to Non-Applicant Stayers | -0.013 | -0.164 | -0.069 | -0.206 | 0.103 | 0.051 | -0.703 | 0.400 | 0.005 | -2.506 | -0.298 |
| | (0.126) | (0.114) | (0.072) | (0.129) | (0.103) | (0.093) | (6.254) | (1.528) | (0.015) | (2.753) | (0.532) |

Note: Experimental estimates are 2SLS estimates where migration is instrumented with the PAC ballot outcome. Controls are gender, age, years of education, height, labor earnings in 2004, and whether the household lives on Tongatapu. Standard errors account for household-level clustering. See text for non-experimental estimates. Individuals of this age are not eligible to migrate under the PAC, so there is only single selection (into migrant families), and not the selection into whose entire family migrates and who migrates for this age. *, **, and *** indicate significance at the 10%, 5% and 1% levels.

**Table 11: P-Values and Family-Wise Adjusted P-Values for Models with Controls**

| | Single Variable P-value | Adjusted P-value for Family-Wise Comparison | | |
|---|---|---|---|---|
| | | Bonferroni | Holm | Westfall-Young Step-Down MinP |
| Adults Aged 18 to 45 | 0.000 | 0.000 | 0.000 | 0.000 |
| Household Size | 0.000 | 0.000 | 0.000 | 0.000 |
| Net Remittances Per Capita | 0.003 | 0.032 | 0.032 | 0.045 |
| Net Remittances Per Adult | 0.005 | 0.062 | 0.057 | 0.069 |
| Household Has ATM card | 0.006 | 0.050 | 0.050 | 0.129 |
| # Meals of Fruits and Vegetables | 0.012 | 0.083 | 0.083 | 0.114 |
| Household Labor Earnings Per Adult Equivalent | 0.014 | 0.163 | 0.135 | 0.107 |
| Adult Waist-to-Hip Ratio | 0.016 | 0.197 | 0.197 | 0.111 |
| Household Labor Earnings Per Capita | 0.020 | 0.237 | 0.178 | 0.138 |
| Number of Chickens | 0.045 | 0.402 | 0.358 | 0.369 |
| Adult BMI | 0.052 | 0.629 | 0.629 | 0.268 |
| # Meals of Fats | 0.064 | 0.446 | 0.382 | 0.307 |
| Household Has Bank Account | 0.068 | 0.614 | 0.477 | 0.434 |
| # Meals of Roots | 0.069 | 0.480 | 0.343 | 0.307 |
| Adult Main Activity Is Agriculture | 0.072 | 0.867 | 0.578 | 0.316 |
| Older Adult in Very Good Health | 0.073 | 0.801 | 0.801 | 0.358 |
| English Literacy for Children | 0.091 | 0.637 | 0.637 | 0.690 |
| Log Total Income Per Adult Equivalent | 0.096 | 1.000 | 0.674 | 0.348 |

Note: This table shows the 18 outcomes for which the experimental estimates are significant (with controls added) at the 10 percent level when examined individually. See the text for more information about how the adjusted p-values are calculated.

## Appendix Table 1: Sample Size

| | Full Sample | Dropping All Movers | Percent All Movers | Dropping Indv Movers | Percent Indv Movers |
|---|---|---|---|---|---|
| | | Individuals | | | |
| Unsuccessful Ballots | 654 | 326 | 50% | 160 | 51% |
| Successful Ballots - Non-Compliers | 115 | 31 | 73% | 11 | 65% |
| Successful Ballots - Migrants | 283 | 283 | | 272 | 4% |
| Non-Applicants | 727 | 641 | 12% | 604 | 6% |
| | | Households | | | |
| Unsuccessful Ballots | 124 | 49 | 60% | | |
| Successful Ballots - Non-Compliers | 26 | 8 | 69% | | |
| Successful Ballots - Migrants | 61 | 61 | | | |
| Non-Applicants | 124 | 107 | 14% | | |

Note: Successful Ballots - Migrants only includes Successful Ballots with members remaining in Tonga.

| Relationship to Principal Applicant in Migrant Households | All Individuals | Percent | Dropping Indv Movers | Percent |
|---|---|---|---|---|
| Principal Applicant | 5 | 1.8% | 5 | 1.8% |
| Spouse | 7 | 2.5% | 5 | 1.8% |
| Own/Adopted child | 20 | 7.1% | 11 | 4.0% |
| Son/Daughter-in-law | 6 | 2.1% | 6 | 2.2% |
| Parent | 45 | 15.9% | 45 | 16.5% |
| Parent-in-law | 4 | 1.4% | 4 | 1.5% |
| Brother/Sister | 73 | 25.8% | 73 | 26.8% |
| Other Relative | 122 | 43.1% | 122 | 44.9% |
| Non-Relative | 1 | 0.4% | 1 | 0.4% |
| Individuals | 283 | | 272 | 11 |

Note: The non-dropped principal applicants, spouses and own/adopted children are outside the age range eligible for the PAC