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ABSTRACT

For many developing countries, international transfers are now a significant source of income. These transfers include official development aid, private charitable donations, and personal remittances. This paper uses dynamic one-sector and multi-sector models to isolate conditions under which transfers could promote growth and structural transformation. Although transfers bring welfare benefits, the effects on investment and growth are modest under isoelastic utility; where investment is profitable, it would be undertaken even in the absence of transfers. Larger effects on growth and sectoral structure emerge when preferences take the Stone-Geary form, since then low investment can co-exist with high returns to investment.

Keywords: foreign aid, remittances, cash transfers, economic growth, structural transformation

JEL classifications: F24, F35, O41

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1 Introduction

For many developing countries, unrequited international transfers are now a significant source of income. These transfers include official development aid, donations from charities and charitable foundations, and international remittances from individuals working abroad. In the early 2010s, rough estimates of the annual global flows would be \$130 billion for official development aid (a combination of grants and concessional loans), \$60 billion for private philanthropy, and more than \$400 billion for remittances to developing countries.¹ In this paper, we study the macroeconomics of transfers: what are their potential welfare benefits, and what difference could they make to economic growth and sectoral structure? When can transfers hasten economic transformation?

The analysis is relevant to a range of policy questions, including the design of future aid programmes. In research and commentary on foreign aid, there is growing interest in the use of cash transfers made directly to developing country households. Blattman and Niehaus (2014) and contributors to Hanlon et al. (2010) argue that transfers direct to households are likely to be superior to more traditional forms of aid. In January 2013, the Indian government launched an ambitious Direct Benefit Transfer scheme, intended eventually to replace multiple welfare programs with cash transfers to households. Using evidence from a randomized trial, Gertler, Martinez, and Rubio-Codina (2012) find that cash transfers to poor households are partly used for investment purposes. Blattman, Fiala and Martinez (2014) carried out a randomized trial of the effects of transfers to poor, unemployed adults in northern Uganda, and found that individuals in the treatment group had significantly higher income than the control group four years later.

This literature is primarily microeconomic, based on individual-level data and findings from randomized trials. Our paper complements this literature by using simple dynamic models to isolate the general equilibrium effects of transfers over longer horizons; these effects are not easily derived from randomized trials or other microeconomic evidence. We consider households that cannot borrow, and hence must finance investment from current income. We study whether transfers made direct to these households will

¹The figures for private philanthropy and remittances are estimates taken from Adelman et al. (2013).

promote capital accumulation, and thereby contribute to aggregate growth and changes in sectoral structure.

Note that personal remittances, official aid flows and charitable giving are components of national income, but do not contribute directly to domestic value added. Instead, they are capital transfers, and will raise subsequent GDP only to the extent that they are invested. Many analyses of the growth effects of transfers — whether foreign aid or remittances — assume that a fixed share of a transfer will be invested, but this conflicts with a large body of research that sees consumption decisions as forward-looking.

When households are seen as making forward-looking investment decisions, the Ramsey model is a natural starting point. We consider several versions of the model, and use it to study the investment response to transfers, and the associated welfare benefits. We initially consider a one-sector model and households with isoelastic utility. We show that the growth effects of transfers are modest in this case. The intuition is that, where investment is profitable, it would be undertaken even in the absence of transfers, as Friedman (1958) observed. We then extend the analysis to Stone-Geary preferences, where the intertemporal elasticity of substitution is low when consumption is low. This ‘subsistence constraint’ implies that low investment can co-exist with high returns to investment: when consumers are close to subsistence, the opportunity cost of investment is high. The effects of transfers on investment and growth can be substantial in the Stone-Geary case.²

The analysis therefore highlights the potential importance of subsistence constraints, broadly interpreted. The microeconomic literature on transfers has often regarded credit constraints as central, but under isoelastic utility, the welfare effects of transfers are modest even in the presence of credit constraints. In the models we consider, to obtain larger growth effects, subsistence constraints are required. This has implications for the external validity of field experiments: transfers will have much larger macroeconomic effects in settings where average consumption is close to subsistence than where it is not. In what follows, we use results from macroeconomic models with heterogeneous

²For our purposes, the key aspect of these preferences is that the intertemporal elasticity of substitution is low when consumption is low. This interpretation should be preferred to one in terms of, say, a minimal nutritional requirement, because of the research finding that calories are relatively inexpensive; see the discussion and references in Kraay and McKenzie (2014).

agents to make this argument more precise.

Our second contribution is to study transfers in a dynamic multi-sector model, again with endogenous investment: following Monteforte et al. (2014), we call this a Lewis-Ramsey model. We consider a small open economy with two sectors, rural agriculture and urban non-agriculture, in which capital and labor are perfectly mobile between sectors, and investment decisions are forward-looking. The influence of transfers on urban employment is an interesting question in itself. Transfers allow faster capital accumulation, which typically leads to an increase in urban employment. Hence, transfers are likely to contribute to structural transformation, and the remaining question is whether this effect is large or small. We show that a large effect can emerge, but in the cases we consider, this happens only when two conditions are met simultaneously: output-capital elasticities must differ significantly across the two sectors, and the intertemporal elasticity of substitution must be low (as when preferences are Stone-Geary and consumption is close to subsistence).

There is another reason for interest in this exercise, which may be less obvious. In principle, the consideration of multiple sectors could modify the welfare effects of transfers. It is well-known that the one-sector Ramsey model predicts implausibly fast convergence. As capital is accumulated, the return to capital declines rapidly from a high level. If the economy converges rapidly to steady-state even in the absence of transfers, this limits the net benefits from investing transfers, in much the same way that Gourinchas and Jeanne (2006) found only modest welfare benefits from opening the capital account. But in multi-sector economies, the returns to capital will often decline more slowly, and the economy will converge to its steady-state path at a slower rate. Intuitively, the key point is that an expanding capital-intensive sector within a larger economy can accumulate labor as well as capital. This limits the extent to which returns to capital decline. These properties of multi-sector models suggest that transfers may have larger welfare benefits than in one-sector models, and this is one of the main questions that we investigate.

The paper has the following structure. Section 2 relates our contribution to the literature. Section 3 considers a one-sector Ramsey model and some associated simulation results; in effect, this extends Obstfeld (1999), partly by solving for dynamic paths,

and computing welfare effects, without the need for linearization. The more innovative contribution of the paper lies in Section 4, which describes a dynamic multi-sector (Lewis-Ramsey) model and its transitional dynamics in the presence of transfers. Finally, section 5 concludes.

2 Discussion

International transfers clearly have direct benefits for domestic consumption and welfare, but their macroeconomic effects remain uncertain. Given the limitations of the available data, and the many confounding factors, it is hard to establish definitive evidence that foreign aid has raised growth rates (see Temple, 2010). Similarly, the benefits of international remittances for productivity can be questioned. The following passage from Barajas et al. (2009), pp. 16-17, cited in Clemens and McKenzie (2014), testifies to this sense of disappointment:

our findings suggest that decades of private income transfers — remittances — have contributed little to economic growth in remittance-receiving economies and may have even retarded growth in some... Perhaps the most persuasive evidence in support of this finding is the lack of a single example of a remittances success story: a country in which remittances-led growth contributed significantly to its development. Given that some countries' remittance receipts exceeded 10% of GDP for long periods of time, we should expect to find at least one example of this phenomenon during the past four decades. But no nation can credibly claim that remittances have funded or catalyzed significant economic development.

Given the apparent lack of success stories, we ask: under what circumstances will transfers make a major difference to development outcomes? Arguably, this question has become increasingly pressing, given the momentum that cash transfers have gained as an effective means of poverty alleviation. Changes in identification and payment technologies, including the 'biometrics revolution' highlighted by Gelb and Clark (2013), mean that transfers can now be made directly to households with relatively little wastage

or leakage.³

The paper will focus on the consequences of cash transfers for aggregate investment and growth. We first adopt the Ramsey model, and isolate conditions under which transfers promote development. Our analysis partly builds on existing findings in the context of foreign aid. In a key paper, Obstfeld (1999) used simulations to study the effects of foreign aid in a version of the Ramsey model. He found that aid makes little difference to the path of capital accumulation, and the effects of aid on growth are accordingly modest.⁴ This can be related to a long-standing observation, associated with Friedman (1958) and Bauer (1969, 1971), that profitable investment would be undertaken even in the absence of international transfers.⁵ From this perspective, it is unlikely that transfers will significantly alter an economy's aggregate investment rate.

It has long been understood that, in the Ramsey model, even an ongoing transfer does not change the height of the balanced growth path for output per worker.⁶ This is because an exogenous transfer does not alter the terms of the intertemporal trade-off between higher consumption today or a higher capital stock tomorrow. But since a transfer does increase the lifetime resources available to a recipient, it allows higher consumption, and also allows an economy below its growth path to converge more rapidly to the steady-state. Transfers such as aid and remittances then promote growth to the extent that they spur faster convergence to that steady-state growth path. The nature of the model's transitional dynamics plays a central role.

This approach has a major drawback, however. The transitional dynamics of the one-sector Ramsey model with isoelastic utility often seem unrealistic when compared with observed growth experiences. In the early stages of a transition, the model generates a sharp decline in the return to capital, together with very high productivity growth,

³The randomized trial implemented by Muralidharan et al. (2014) supports the idea that biometric authentication can make welfare programs significantly more cost-effective.

⁴To be more precise, Obstfeld assumes that some consumers do not save, but consume all their income; otherwise the model is standard. An earlier paper by Boone (1996) considered a Ramsey-type model with endogenous tax rates and internal transfers, but did not analyse its transitional dynamics. Another strand in the literature assumes that aid can be used to finance public investment, as in Chatterjee et al. (2003) and other work summarized in Turnovsky (2009), and in Bouza and Turnovsky (2012). The implications of the Ramsey model for the principles of aid allocation are studied in Carter (2014) and Carter et al. (2014).

⁵This view is discussed further in Eaton (1989), Temple (2010), Deaton (2013) and Carter (2014), among others. Temple and Van de Sijpe (2014) present evidence that aid mainly translates into higher household consumption rather than higher investment.

⁶Brakman and van Marrewijk (1998, chapter 10) analyse the question from the point of view of the donor.

neither of which seem to be observed in the data. One of the best-known demonstrations is that in King and Rebelo (1993), who illustrated the problem using a version of the model calibrated to the post-war growth of Japan. The more general problems of the Ramsey model are discussed in Barro and Sala-i-Martin (2004), among others. They emphasize that the transitional dynamics of the Ramsey model become more plausible if capital is defined broadly, with an aggregate output-capital elasticity that substantially exceeds capital's share of value added.

Several alternative responses are possible: we consider two of them, and study their implications for the aggregate effects of transfers. The introduction of Stone-Geary preferences, in which the intertemporal elasticity of substitution is especially low when consumption is low, can generate more realistic growth paths. Under these preferences, investment may be deferred, and hence Christiano (1989) calls this the *slow convergence model*. A different solution is to consider a multi-sector economy, in which reallocation across sectors slows down the decline in the return to capital as capital is accumulated. Again, in multi-sector economies, it is likely that convergence will be slower than in the standard Ramsey model. But when we analyze these two alternatives in quantitative terms, it becomes clear that Stone-Geary preferences are the most direct route to large investment and welfare effects of transfers.

It is interesting to relate these findings to recent evidence from randomized trials. When the responses of low-income individuals to cash transfers have been studied using trials, the evidence seems to point to significant income gains (relative to a control group) several years later, consistent with the idea that different investment decisions would have been taken in the absence of transfers. For example, Blattman, Fiala and Martinez (2014) study the effects of cash transfers to poor and unemployed adults in Uganda on transitions into self-employed trades. Based on a randomized trial, they find large effects, consistent with the idea that credit constraints matter. In a separate trial of transfers to the 'ultra-poor' in Uganda, Blattman et al. (2014) also find high returns.

These results can be attributed to credit constraints, but that is not a complete explanation. Throughout our quantitative analysis of the Ramsey model, we will assume that households cannot borrow: investment must be financed from current income. But under isoelastic utility, we confirm Obstfeld's finding that transfers make relatively little

difference to capital accumulation, regardless of the borrowing constraint. Obstfeld writes that the result is ‘likely to be a robust feature of any plausible model in which aid is funneled through the private sector’ (Obstfeld 1999, p. 136). The explanation is that investment would have been undertaken in any case, and convergence to the steady-state would be rapid. But we will show that transfers have much larger investment effects under Stone-Geary preferences. In that case, initial investment may be low even when the returns to capital accumulation are high, because the opportunity cost of investment is also high.

It has often been argued that Stone-Geary preferences help to bring the predictions of the one-sector Ramsey model closer to the data.⁷ Under these preferences, the intertemporal elasticity of substitution is increasing in the level of consumption. A wide range of evidence, at various levels of aggregation, supports this proposition. In the aggregate data, there is clear evidence that rates of saving or investment are lower in poor countries than in rich ones, as documented in Kraay and Raddatz (2007) and Sachs (2005), among others. Among microeconomic studies, Rosenzweig and Wolpin (1993) studied livestock investment decisions in India and estimated a subsistence level of consumption equal to around half of mean household food consumption; this implies the intertemporal elasticity of substitution is lower for poorer households. Atkeson and Ogaki (1996) and Ogaki and Atkeson (1997) also reach this conclusion, based on panel data for Indian households. In a more recent study, Bryan et al. (2014) find evidence for rural Bangladesh that an investment which is often likely to be profitable — temporary out-migration during the lean season — is not always undertaken, and explain this by the proximity of many households to a subsistence constraint, combined with the risk that out-migration may be unsuccessful. In keeping with this explanation, their evidence from a randomized trial finds larger effects of cash transfers on the migration decisions of those close to subsistence.⁸

⁷References include Christiano (1989), Rebelo (1992), King and Rebelo (1993), Ben-David (1998), Kraay and Raddatz (2007), Ohanian et al. (2008) and Steger (2009).

⁸A variable intertemporal elasticity of substitution is also consistent with much of the microeconomic literature on consumption even for developed countries: see Attanasio and Browning (1995), Blundell, Browning and Meghir (1994) and Crossley and Low (2011). The theoretical importance, and wide-ranging implications, of a variable intertemporal elasticity of substitution have been emphasized by Bliss (2007, 2008).

These different pieces of evidence all suggest that subsistence constraints could be central in understanding investment decisions in poorer countries, and we study them in detail. In all our various experiments, we will treat technical progress as exogenous, and study only the effects of aid that work via capital accumulation. This choice of emphasis is broadly consistent with the findings of Schelkle (2014): using results from development accounting, he finds that episodes of international catching up (relative to the United States) are primarily associated with factor accumulation rather than changes in relative efficiency. This justifies a focus on the transitional dynamics of growth models, rather than endogenous rates of technical progress, in understanding the aggregate effects of transfers.

Our work could also be seen as relevant to the literature on resource windfalls. In particular, that literature has considered the extent to which windfalls should be consumed or invested, as in van der Ploeg and Venables (2012) and Venables (2010) among others. In contrast to our paper, that literature often emphasizes the instability of resource rents, and the potential for Dutch Disease effects, including movements from manufacturing to services, as in Kuralbayeva and Stefanski (2013). We abstract from those considerations in the analysis that follows. In principle, the dynamic multi-sector model that we adopt could be extended to consider Dutch Disease effects, along the lines of the models in Bouza and Turnovsky (2012) or Roe et al. (2010).

Part of the background to our paper is the perception that structural transformation has been delayed in Africa in particular, or even worked against raising aggregate productivity. McMillan and Rodrik (2012) and McMillan, Rodrik and Verduzco-Gallo (2014) argue that changes in sectoral structure in Africa have sometimes favoured sectors with relatively low productivity at the margin. Page (2012) argues that aid policies are partly responsible for the lack of structural transformation in Africa. This helps to motivate the study of whether transfers can hasten structural transformation, for model economies with starting positions similar to those of contemporary sub-Saharan African countries.

Among existing work, other papers related to ours include Bouza and Turnovsky (2012) and Buera et al. (2014). The former paper uses a two-sector ‘dependent economy’ model to study the effects of exogenous foreign transfers on inequality in wealth, income and welfare. The latter paper emphasizes the effects of asset redistributions on

occupational choice, when there are frictions in credit markets. Both papers emphasize heterogeneity, and study distributional effects. In contrast, our paper will focus on the relationship between exogenous transfers and aggregate outcomes, including structural transformation, especially in the context of subsistence constraints.

3 The one-sector model

We first consider a closed, one-sector economy which receives an unrequited capital transfer at each instant. We could think of this transfer as official development aid, charitable flows, or international remittances. There are no other international capital flows, and since households are identical, they must finance their investment from current income. This does not seem an unrealistic assumption for the poorest countries, and is broadly consistent with evidence that credit constraints matter for low-income households.

Time is continuous, with an infinite horizon, and there is no uncertainty, allowing us to focus on the medium-run transitional dynamics as they unfold over decades. As in Gourinchas and Jeanne (2006), we consider the population as distributed among identical households or dynasties, which grow in size at a constant rate n . Each member of the household supplies one unit of labor inelastically. We use k and c to denote capital per worker and consumption per worker, respectively, and a to denote the transfer per worker. We write the production function in per-worker terms as $f(k, A)$, where A denotes labor-augmenting efficiency. For example, with a Cobb-Douglas technology, we have $y = k^\mu A^{1-\mu}$.

The representative dynasties are each solving the following optimal control problem:

$$\begin{aligned} \max_{\{c(t)\}} U &= \int_0^\infty u(c(t)) \cdot L(t) \cdot e^{-\rho t} dt \\ \text{subject to: } \dot{k}(t) &= f(k(t), A(t)) + a(t) - c(t) - (\delta + n)k(t) \\ k(0) &\text{ given.} \end{aligned}$$

and where a standard transversality condition also applies. In what follows, we suppress the time index except where its inclusion is useful for clarity. Factor markets are

perfectly competitive, and again for simplicity, we can think of the exclusive decision-makers as private households which carry out production and investment directly, rather than indirectly via firms. The intertemporal choices of the households will satisfy a standard Euler equation:

$$\frac{\dot{c}}{c} = \frac{1}{-\varepsilon_{u'(c)}} (f_k(k, A) - (\rho + \delta))$$

where $\varepsilon_{u'(c)}$ is the elasticity of marginal utility with respect to consumption, equal to $-\sigma$ in the case of isoelastic utility, where $1/\sigma$ is the intertemporal elasticity of substitution.

We will consider two cases for the instantaneous utility function: isoelastic utility, and Stone-Geary preferences. With Stone-Geary preferences, instantaneous utility is given by:

$$u(c) = (c - \bar{c})^{1-\sigma} / (1 - \sigma)$$

where $\bar{c} \geq 0$ is sometimes interpreted as a subsistence level of consumption. But the assumption that $\bar{c} > 0$ does not need to be interpreted as an empirical claim about the cost of subsistence, such as a minimum consumption requirement. Instead, these preferences are a simple way to capture the idea that the intertemporal elasticity of substitution is increasing in the level of consumption, which seems to be the empirically relevant case. An economy where consumption is close to the level $\bar{c}$ will fail to grow, because households are too poor to want to undertake investment. As noted earlier, this is a simple way to capture the co-existence of low investment rates and high returns to investment.

In the version of the Stone-Geary economy that we consider, technical progress eventually renders the subsistence consumption constraint irrelevant. The balanced growth path is asymptotic, as in other analyses of one-sector models with these preferences; see, for example, Ohanian et al. (2008). The intertemporal elasticity of substitution is equal to $(c - \bar{c})/\sigma c$ and hence approaches $1/\sigma$ as $\bar{c}/c$ approaches zero. The steady-state capital-output ratio, output per worker, and consumption per worker are the same as in the isoelastic utility case, but the transitional dynamics may be very different.

In the case where the production technology is Cobb-Douglas with an output-capital

elasticity of μ , steady-state output per worker is given by the standard expression:

$$y^* = A \left(\frac{\mu}{\rho + \delta + \sigma \cdot g_m} \right)^{\frac{\mu}{1-\mu}}$$

One advantage of this simple framework is that we can quantify the benefits of transfers for the welfare of the households in the model. We study this using Hicksian Equivalent Variation (HEV) as in Gourinchas and Jeanne (2006) and Carter, Postel-Vinay and Temple (2014). This provides a metric for comparing lifetime utility with a transfer to the lifetime utility that would obtain under a baseline scenario without the transfer. The HEV is the constant proportional change in consumption at each instant, relative to the baseline, that would lead to the same lifetime utility as the alternative scenario of interest. Under isoelastic utility, with an intertemporal elasticity of substitution of $1/\sigma$, this is given by:

$$\lambda = \left(\frac{U_{aid>0}}{U_{aid=0}} \right)^{\frac{1}{1-\sigma}} - 1$$

if $\sigma \neq 1$, and $\lambda = \exp((\rho - n)(U_{aid>0} - U_{aid=0})) - 1$ if $\sigma = 1$. In the Stone-Geary case, there is no closed-form expression for the HEV, and we will solve for it numerically. Note that the computed welfare benefits from aid should not be compared across different specifications for preferences.

One property of isoelastic preferences in a growing economy is worth some discussion. If the economy has already reached its balanced growth path, then the entirety of a transfer will be consumed, and net investment will be zero if population growth is zero. If the transfer is assumed to grow in line with GDP, then λ will be equal to the ratio of the transfer to GDP net of depreciation. In the case of population growth, net investment will be strictly positive even along the balanced growth path, and the denominator in the calculation of λ will be GDP minus net investment.

We have to specify the level of the transfer and how it evolves over time. We follow a similar approach to Carter and Temple (2014) and assume the existence of a donor — not modelled — which grows at a constant rate equal to the rate of technical progress g_m , and which donates a fixed share of its income.⁹ Since transfers can be a major

⁹Note that the existence of a steady-state requires that the asymptotic growth rate of the transfers is no higher than g_m .

source of income for some developing countries, we consider a transfer equal to 20% of the initial output of the recipient economy, and which then grows at the constant rate g_m . There are many developing countries for which official development aid accounts for 20% of national income; see, for example, Temple (2010), Table 2. The assumption that the transfer grows in line with output along the balanced growth path differs from Obstfeld (1999), but is not central to our results.

Our remaining assumptions follow Obstfeld (1999) closely. We assume a Cobb-Douglas production function with constant returns to scale and an output-capital elasticity of 0.40. We assume a discount rate of $\rho = 0.03$, a depreciation rate of $\delta = 0.10$, and $\sigma = 2.5$, where the last assumption is based on the estimates of Ostry and Reinhart (1992) for developing countries. The rate of labor-augmenting technical progress g_m we set to 0.018, the value used in Temple and Ying (2014) and close to the value of 0.02 adopted in Mankiw, Romer and Weil (1992). We set population growth to $n = 0.01$. Note that these assumptions, and the others we consider later, satisfy $\rho > n + (1 - \sigma)g_m$, the standard condition under which lifetime utility in the Ramsey model is finite.

Under our assumptions, the equilibrium capital-output ratio is equal to 2.29. The initial level of capital per effective worker ($\equiv k/A$) is set to 10% of its steady-state value. This implies that the capital-output ratio in these simulations will increase from 0.5741 to 2.29, which is a four-fold increase; for comparison, Obstfeld (1999) studied a three-fold increase.

To carry out the simulations, we use the relaxation algorithm of Trimborn et al. (2008). This algorithm allows us to solve for the paths of all variables in the system, without the need for the approximations around the steady-state that were used in Obstfeld (1999) and related papers. This is a particular gain when we consider models where convergence to the steady-state is slow, as will sometimes arise under Stone-Geary preferences, or the multi-sector structure considered later.¹⁰

In our first simulation, we consider isoelastic utility and hence set $\bar{c} = 0$. The first panel of figure 1 shows the path of the capital-output ratio with and without a transfer. It is clear that, as in Obstfeld (1999), the transfer makes relatively little difference to the

¹⁰Atolia et al. (2010) emphasize the relevance of the convergence speed, and note that the errors introduced by linearization can be especially important for welfare calculations.

path of the capital-output ratio. Since the transitional dynamics are barely affected by transfers, their effects on growth rates will be modest. This model would find it hard to rationalize the evidence from randomized trials discussed earlier, even though the model is one where investment can be financed only from current income.

Next, we consider Stone-Geary preferences, and choose a high $\bar{c}$ to equal 90% of initial output. This is an extreme case, which implies that the intertemporal elasticity of substitution is very low at the start of the transitional dynamics.¹¹ The convergence of the capital-output ratio to its steady-state value is then much slower, as shown in the second panel of figure 1. Under these preferences, there is an interval of time over which net investment is minimal and consumption growth is slow. Figure 2 contrasts the path of the investment rate under isoelastic utility (the upper line) with the path under Stone-Geary preferences (the dashed line), showing how these preferences lead investment to be deferred when the initial capital stock is low.

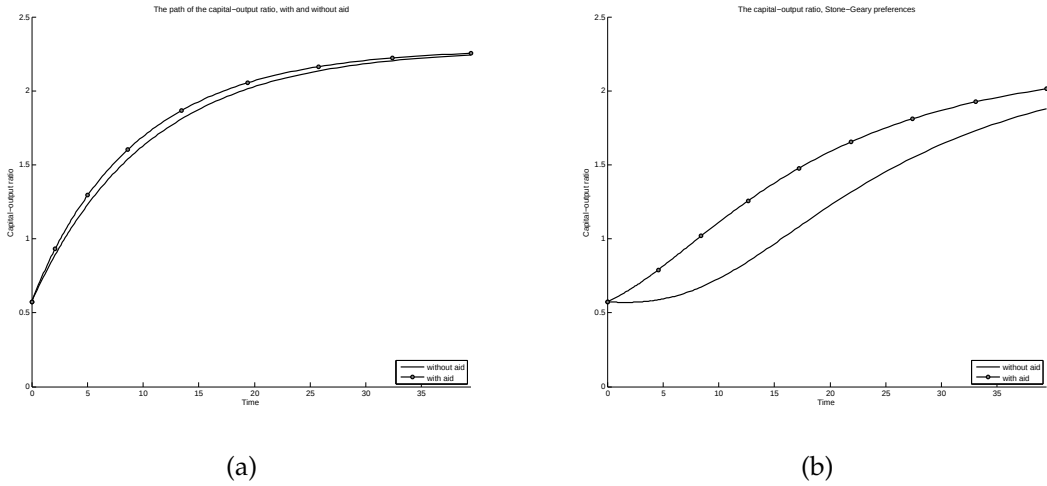


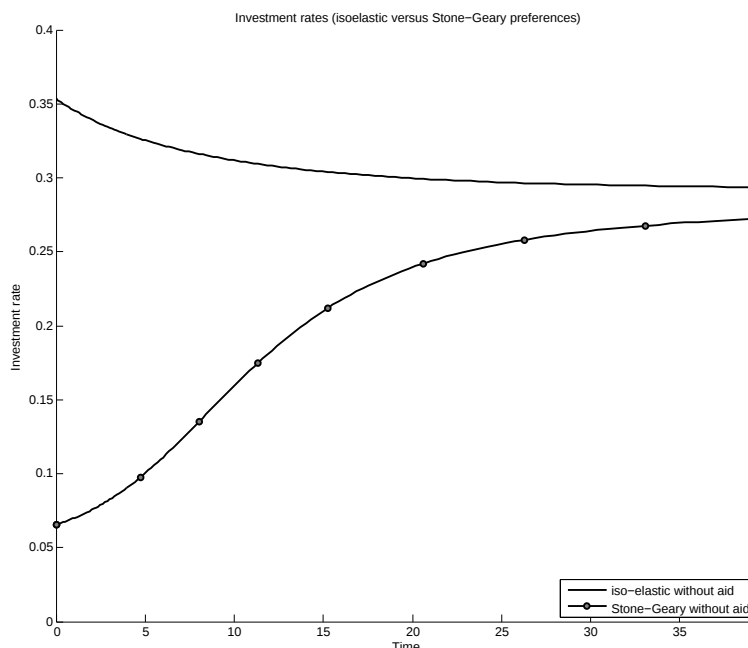
Figure 1: (a): Isoelastic preferences (b): Stone-Geary preferences

These figures show the path of the capital-output ratio, for isoelastic preferences and Stone-Geary preferences.

We now compare the (log) consumption paths with and without a transfer. These are shown in the first panel of figure 3. It can be seen that the transfer raises the consumption path, especially early on in the case of Stone-Geary preferences. Under isoelastic preferences, the increase in welfare induced by the transfer is equivalent to

¹¹In further work, we will consider less extreme cases. Throughout, we assume that the initial capital stock is sufficiently high that consumption can be maintained above the subsistence threshold $\bar{c}$ indefinitely.

Figure 2: Investment rates under isoelastic and Stone-Geary preferences



This figure shows the path of investment rates under isoelastic utility (solid line) and under Stone-Geary preferences (dashed line) in the absence of transfers.

increasing consumption by 18% at each instant. Under Stone-Geary preferences, the increase in welfare is equivalent to a 25% increase in consumption at each instant. Under these preferences, the transfer leads to higher investment early on, as shown in the second panel of 3. This suggests that transfers will have a larger effect on growth rates under Stone-Geary preferences, and this is confirmed by the two panels of figure 4.

There are some clear parallels with the analysis of capital mobility in Gourinchas and Jeanne (2006). Using versions of the Ramsey model, they showed that the welfare benefits of opening the capital account are often modest. Our application of the Ramsey model to unrequited transfers invites similar cautions. The perspective of the model is useful partly because it suggests a change in focus. What matters most is not the share of transfers that will be invested, but the investment rate that would apply in the absence of transfers, how far the economy is below its steady-state growth path, and how fast it is converging to that steady-state.¹²

¹²Also note that, once the investment rate is treated as endogenous, it is not meaningful to ask what share of a transfer is invested at any date other than zero; the relevant question is how the time path of capital differs in the case of a transfer.

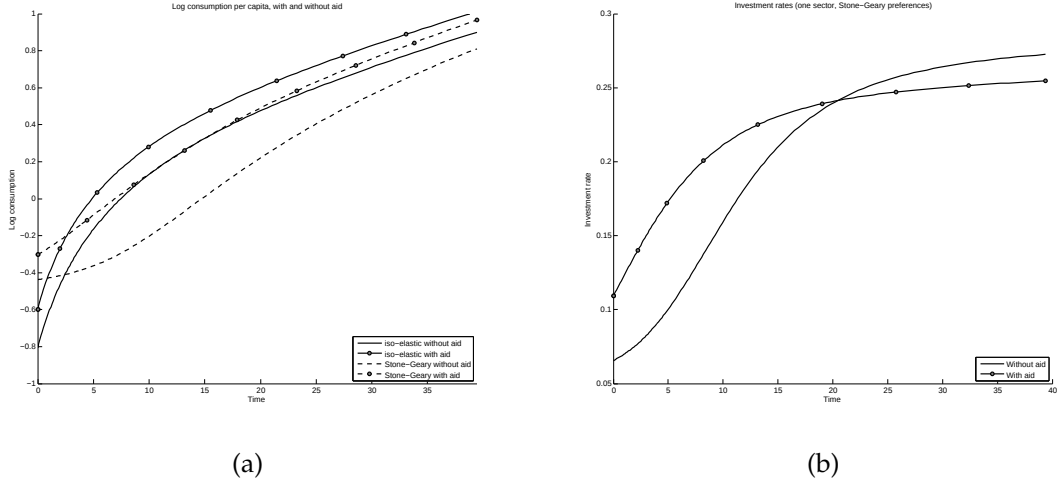


Figure 3: (a): Log consumption (b): Investment rates

These figures show the path of log consumption (under isoelastic preferences and Stone-Geary preferences) and the ratio of investment to GDP under Stone-Geary preferences.

At this point, it may be useful to forestall a potential misunderstanding. The finding that transfers are especially beneficial in an economy with Stone-Geary preferences might suggest that cash transfers — for example, as part of a foreign aid program — should always be directed at the poorest members of a given economy, and will be ineffective otherwise. That interpretation is not quite correct, if we introduce asset heterogeneity into the above model. Under our assumed preferences and perfect capital markets, the paths of aggregate investment, capital and consumption are invariant to the initial distribution of assets across households. Results of this ‘representative consumer’ form are emphasized by Chatterjee (1994), Caselli and Ventura (2000) and Álvarez-Peláez and Díaz (2005). The intuition is that, under an alternative distribution of assets, the saving choices of the heterogeneous households offset each other, leaving the dynamics of aggregate capital and consumption unchanged.¹³ In the model we consider here, if an aid donor can commit to a path of transfers for each household, alternative distributions of the aid across households would not change the dynamics of aggregate investment, capital and consumption. (The evolution of wealth inequality would be affected, however.) The intuition is that household consumption is an affine function of wealth, so that transfers could be reallocated across households without

¹³The relevant property of the model is that, in the current setting, the consumption function is linear in wealth: see Chatterjee (1994).

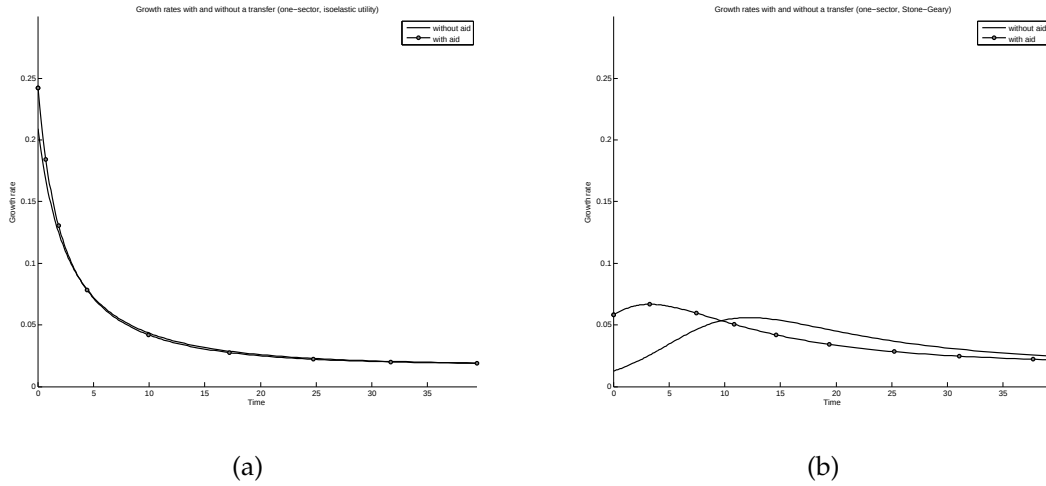


Figure 4: (a): Isoelastic preferences (b): Stone-Geary preferences

These figures show the effects of transfers on growth rates. The solid line is without a transfer, and the dashed line with a transfer. The transfer is equal to 20 per cent of the recipient's initial output, growing at the rate of technical progress in perpetuity.

affecting aggregate consumption and investment.

Hence, what we have shown is not that transfers should be directed to the poorest members of a given economy. Instead, our simulations indicate that, for transfers to a given economy to have large effects on investment and growth, the economy should be one where the average level of consumption is (initially) not too far above the subsistence threshold. There would still be a case for directing transfers at the poorest members of that economy, because of diminishing marginal utility and/or distributional concerns about wealth inequality; but prioritizing the poor, in the setting considered here, would make no difference to the benefits of transfers for aggregate investment, consumption and growth.

We have emphasized Stone-Geary preferences, but other modifications to the analysis could also generate larger welfare effects. Our chosen discount rate places considerable weight on outcomes distant in time, which works against finding large benefits from accelerating convergence to steady-state.¹⁴ Note, however, that varying the discount rate has several effects, because it also changes the height of the balanced growth path. In the Cobb-Douglas case, it is easy to show that the elasticity of steady-state output per

¹⁴For this and other arguments, see the Obstfeld and Taylor (2004, chapter 8) discussion of the working paper version of Gourinchas and Jeanne (2006).

worker with respect to the discount rate is given by $-(\rho/(\rho + \delta + \sigma \cdot g_m))(\mu/(1 - \mu))$. At our baseline parameter values, this elasticity is therefore -0.114, so increasing the discount rate has an effect on the balanced growth path which is large enough to influence growth rates and the welfare calculations. But in practice, the effects of varying ρ on the HEV are modest under isoelastic utility: for $\rho = 0.06$, the HEV is 18.7%, and for $\rho = 0.09$, the HEV is 19.5%: see Table 1 for more details. Hence, our welfare calculations under isoelastic utility are robust to alternative choices of ρ .

Table 1: Alternative discount rates

ρ	k_0/k_{SS}	HEV
0.03	0.10	17.6%
0.06	0.13	18.7%
0.09	0.16	19.5%

Source: Authors' simulations

A more far-reaching modification would be to consider capital varieties which are imperfect substitutes, as in the analysis of capital mobility in Hoxha, Kalemli-Ozcan and Vollrath (2013), and the study of 'bottleneck' capital in Rappaport (2006).

4 A two-sector model

For most developing countries, economic transformation is partly a structural transformation, from a largely agricultural economy to one dominated by manufacturing and services. Hence, we now consider the effects of transfers in a dynamic multi-sector model. In principle, the effects of transfers on investment, growth and convergence, and their welfare benefits, could look very different. Several authors, notably Robertson (1999), have observed that the transitional dynamics of the Ramsey model are likely to be more plausible in a two-sector economy, especially when that economy is open to trade. In some standard trade models, factor prices will be independent of factor supplies over a range of factor endowments. The return to capital will then be invariant to the capital stock; as capital is accumulated, reallocation across sectors maintains the return to capital at a constant level.¹⁵ In more general models, the return to capital is

¹⁵This result was highlighted by Leamer (1987), and plays a central role in Ventura (1997) and other work on growth which draws on Heckscher-Ohlin models; see Ventura (2005) and chapter 19 of Acemoglu

likely to change over time, but reallocation across sectors will limit the extent of its decline. This raises the possibility that, in a two-sector model, transfers will have a larger impact on capital accumulation than in the one-sector case. If this is right, the welfare benefits of transfers may be larger than in Obstfeld (1999).

These considerations suggest the importance of considering multiple sectors. But analysis of multi-sector growth models has been complicated by their lack of closed-form solutions, outside unlikely special cases.¹⁶ The models generally have to be studied numerically, and linearization can give misleading results for multi-sector models, where the rate of convergence to the steady-state may be slow. Moreover, in the Stone-Geary case, the dynamics in the neighborhood of the steady-state — where the subsistence constraint vanishes asymptotically — are likely to be very different from those early in the transition, when the subsistence constraint is relevant.

We adopt a simple two-sector, three-factor growth model with an asymptotic balanced growth path and forward-looking investment decisions; following Monteforte et al. (2014), we call this a Lewis-Ramsey model.¹⁷ To solve the model numerically, we use the procedure suggested by Monteforte et al. (2014), which avoids the need for linearization. It also allows fast, reliable solutions even though balanced growth applies only asymptotically. Their approach is based on rewriting the system of differential equations in terms of an additional state variable with a known dynamic path, and then solving the expanded system using the relaxation algorithm of Trimborn et al. (2008).

In more detail, we consider a small open economy with two sectors, in which the outputs of both sectors are traded on world markets. We assume there is a rural sector which produces an agricultural good, and co-exists with an emerging urban ‘non-agricultural’ sector that produces a composite good. The composite good can be interpreted as a bundle of manufacturing goods and services. To keep the analysis simple, we abstract from the distinction between manufacturing and services. As before, we work in continuous time with no uncertainty, and an infinite horizon.

For simplicity, the economy is again closed to international capital flows other than

(2009). Feenstra (2004) provides a textbook discussion of ‘factor price insensitivity’ results.

¹⁶For a literature review, see Herrendorf et al. (2014).

¹⁷The model is related to, but simpler than, the multi-sector Ramsey model considered in Spolador and Roe (2013) and the closed economy, multi-sector Ramsey models described in Irz and Roe (2005) and chapter 3 of Roe et al. (2010).

unrequited exogenous transfers. The economy we consider is assumed too small to influence world prices through its consumption or production decisions. A major advantage of these assumptions is that we do not have to specify household preferences. Instead, the price of the agricultural good relative to the price of the non-agricultural good will be determined exogenously, by world prices, and this relative price will influence the allocation of factors of production across sectors. Given that we allow for international transfers, national income and expenditure will both exceed domestic output. At any given instant, imports will exceed exports in total value. For the issues we consider here, however, the trade pattern is of secondary interest. In the terminology of trade theory, we are considering a production equilibrium, and this is sufficient for our purposes.¹⁸

The two sectors, rural agriculture and urban non-agriculture, are denoted by subscripts a and m respectively. Agriculture produces output using labor L_a , capital K_a , and land R ; non-agriculture produces output using labor L_m and capital K_m . The stock of land is fixed and its units chosen so that it can be normalized to one. The production technologies in each sector have constant returns to scale, and are given by:

$$Y_a = F(R, K_a, A_a \cdot L_a)$$

$$Y_m = G(K_m, A_m \cdot L_m)$$

where A_a and A_m are the sectoral levels of labor-augmenting efficiency, growing at the (exogenous and constant) rates g_a and g_m respectively. We treat the non-agricultural good as the numéraire, and the relative price of the agricultural good is denoted p . Aggregate nominal output is then given by:

$$Y \equiv p \cdot Y_a + Y_m \tag{1}$$

Again for simplicity, we restrict attention to cases where the relative price is constant over time, and hence Y can also be taken as a measure of real GDP.

The role of land in the model is worth noting. Without land, the economy we de-

¹⁸Previous quantitative studies of a general equilibrium model of production include Graham and Temple (2006), but their analysis is not dynamic.

scribe would be a dynamic version of the standard 2×2 model from trade theory. For dynamic analysis, the 2×2 model has the major drawback that the economy will be completely specialized in one sector or the other for some ranges of the capital-labor ratio. This implies that the model would switch regimes over time. The inclusion of land in agriculture avoids this problem: although agriculture's share of employment and output will approach zero asymptotically, the sector will never close down completely. This means that the economy can be described by the same set of equations throughout, which greatly simplifies the numerical solution of the model.¹⁹

We assume that labor is perfectly mobile between the two sectors, and in each sector, receives a wage equal to its marginal product. For the sectoral equilibrium at each instant, we require wages to be equalized:

$$w_a = p \cdot F'_{L_a}$$

$$w_m = G'_{L_m}$$

$$w_a = w_m$$

All capital will be fully utilized in equilibrium, so K_a and K_m sum to the total capital stock K . Capital can move freely between sectors, so that returns are equalized at each instant:

$$p \cdot F'_{K_a} = G'_{K_m} \tag{2}$$

This will also be the return to holding land; in principle, we could solve for the path of the price of land, which would be the path needed to ensure the returns to holding capital and land are equal at each instant (Roe et al. 2010).

As before, the population grows exogenously at rate n , which we consider to be growth in the size of representative dynasties. We now consider the investment decisions made by these households, given that they discount the future at rate ρ . Each household is considered to maximize:

¹⁹An alternative approach would be to construct a model which is dynamically recursive, but this would require us to abandon forward-looking investment decisions. Hansen and Prescott (2002) consider a dynamic model with more than one regime.

$$U = \int_0^{\infty} u(c(t)) \cdot L(t) \cdot e^{-\rho t} dt \quad (3)$$

subject to the intertemporal resource constraint

$$\dot{k}(t) = y(t) + a(t) - c(t) - (n + \delta) \cdot k(t) \quad (4)$$

and a standard transversality condition. Lower-case letters denote quantities divided by total employment; for example, $y \equiv Y/L = (pY_a + Y_m)/L$. The resources available to domestic households again include exogenous cash transfers per worker, denoted by $a(t)$. National income per worker is therefore $y(t) + a(t)$. Solving this optimal control problem yields a standard Euler equation which, as before, pins down the slope of the consumption path as a function of the single state variable, $k \equiv K/L$.

Our assumptions imply that structural change continues indefinitely, with the share of the agricultural sector in total employment approaching zero asymptotically, as in Hansen and Prescott (2002). The growth rate of GDP per capita will asymptotically approach the rate of efficiency growth in non-agriculture, g_m . When solving the system of equations numerically, we convert the system into quantities measured in common efficiency units, so that capital, sectoral outputs, total output and consumption are divided by the level of efficiency in the non-agricultural sector, and by total employment.

First of all, we consider the welfare effects of transfers that obtain in a two-sector economy undergoing a structural transformation. Both economies are calibrated so that their initial conditions are similar. The two-sector economy we consider will asymptotically approach the growth path of a one-sector model, and hence the two economies can be calibrated so that they share the same balanced growth path. Hence, the differences between the one-sector and two-sector simulations can genuinely be attributed to the differences in transitional dynamics between the two cases, and not to differences in their growth paths.

This is less easily achieved than at first glance, however. It is not possible to assume the same production technology for non-agriculture, and still match both initial output and initial capital across the one-sector and two-sector cases. The intuition is that an economy which has access to two production technologies will generally be better off,

for a given level of aggregate capital, than an economy which has access to only one of those technologies.

With this in mind, we make a modification to the two-sector economy. We assume, as in Monteforte (2011), that a fraction of the agricultural labor force is relatively unproductive; we could think of these as uneducated peasants. If we denote the share of peasants in the total labor force by l_p and the share of non-peasants by l_a , then the total supply of productivity-adjusted labor in agriculture will be written as $L_a \equiv (l_a + \psi \cdot l_p)L(t)$ where $\psi < 1$. We assume that ψ is constant over time, that the share of peasants in the total labor force declines to zero at an exogenous rate, and that the economy can be thought of as comprising identical representative dynasties of households whose demographic composition (of peasants versus non-peasants) mirrors that of the economy as a whole. Under these assumptions, we can calibrate the value of ψ so that the two-sector economy is no more productive than the one-sector economy for a given initial capital stock. If l_p goes to zero relatively quickly, the implications for the medium-term transitional dynamics will be modest.

Our use of a two-sector model requires additional parameter assumptions. These will follow Temple and Ying (2014) closely. As in that paper, certain parameters are chosen to match selected characteristics of Malawi in 2010. We are not seeking to match historical data for Malawi, or to make predictions about its future growth — not least because other parameters are chosen mainly for comparability with Obstfeld (1999). Instead, we consider the potential effects of transfers made over the course of a hypothetical structural transformation, to gain a sense of which considerations may be most important.

We consider an economy in which agriculture initially employs 65% of the labor force, drawing on the data for Malawi in the Africa Sector Database of de Vries et al. (2013); see in particular their Appendix Table C5. We assume that both sectors use Cobb-Douglas production functions with constant returns to scale:

$$Y_a = R^\alpha K_a^\beta (A_a L_a)^{1-\alpha-\beta}$$

$$Y_m = K_m^\mu (A_m L_m)^{1-\mu}$$

We choose the output-capital elasticity in non-agriculture, μ , to equal 0.40, the value used by Obstfeld (1999) and adopted in the one-sector model studied above. We set the output-land elasticity in agriculture to $\alpha = 0.16$, as in Temple and Ying. A key role will be played by the output-capital elasticity in agriculture, β ; we try the same figure, $\beta = 0.38$, as in Temple and Ying, and sometimes consider a lower alternative, $\beta = 0.15$. We continue with $g_m = 0.018$ as before, and set $g_a = 0.014$. Other parameter settings and initial conditions match those in the simulations of the one-sector model considered previously.

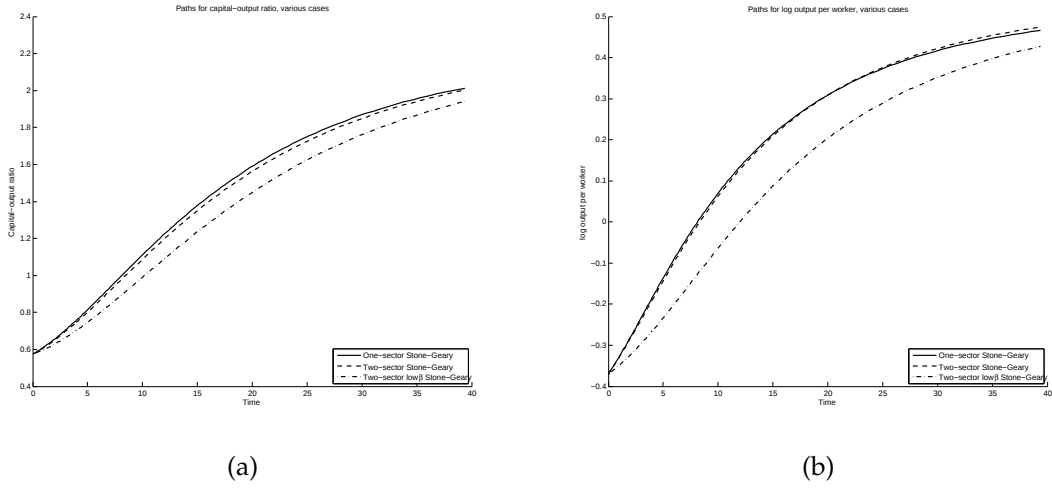


Figure 5: (a): Capital-output ratio (b): Log output per worker

These figures show the capital-output ratio and log output per worker. The solid line is the one-sector case, the dashed line the two-sector case with high β , and the dashed-dotted line is the two-sector case with low β .

We will mainly focus on the case of Stone-Geary preferences, in which transfers allow faster accumulation early in the development process, with consequences for sectoral structure and aggregate growth. In the first panel of figure 5 we show paths of the capital-output ratios for various forms of the two-sector model. The two-sector model with high β — and hence output-capital elasticities that are similar across the two sectors — exhibits transitional dynamics that are very similar to the one-sector model. But with a lower β , it is clear that the two-sector economy converges to the balanced growth path more slowly. We can see this again in the paths of (log) output per worker, shown in the second panel of figure 5.

We can also study factor prices. The paths of (log) wages are shown in the first panel

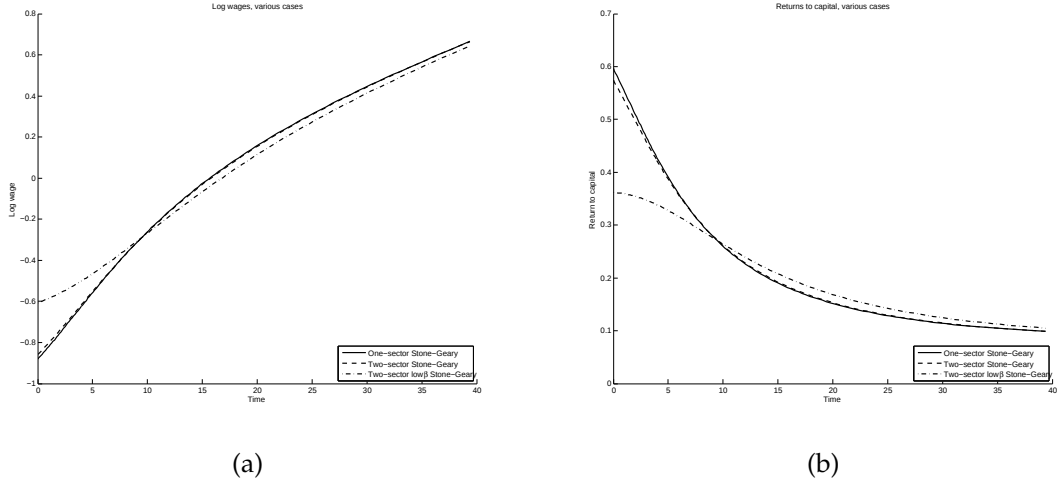


Figure 6: (a): Log wages (b): Returns to capital

These figures show log wages and the returns to capital. effects of transfers on growth rates. The solid line is the one-sector case, the dashed line the two-sector case with high β , and the dashed-dotted line is the two-sector case with low β .

of figure 6 for the different models. Note that the initial wage is higher in the two-sector model with low β , because workers now have access to a labor-intensive sector, agriculture. Since the agricultural sector disappears asymptotically, the paths of wages ultimately converge. The second panel of figure 6 shows the time paths of the returns to capital, net of depreciation. It can be seen that, in the case of low β , the return to capital is initially lower, and declines less, over the course of a transition. This is the result emphasized by Robertson (1999). In principle, this should change the welfare benefits associated with transfers.

Next, we examine the effects of transfers on sectoral structure. Figure 7 shows that transfers make little difference to the extent of structural transformation when β is high. But with a lower β , and Stone-Geary preferences, transfers can hasten structural transformation. This is shown in figure 8, where the transfer makes a marked difference to the path of the employment share. Intuitively, if the output-capital elasticities for the two sectors are further apart, the path of structural change becomes more sensitive to the rate at which capital is accumulated. Acemoglu and Guerrieri (2008) emphasized the role of sectoral differences in factor proportions in shaping structural transformation and aggregate growth.

Finally, we can consider the effects of transfers on the growth rate of GDP per worker.

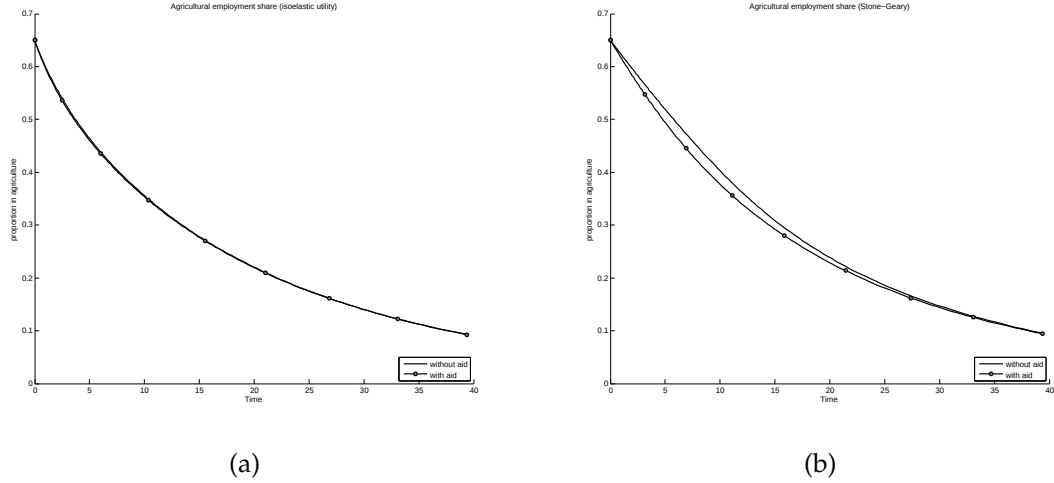


Figure 7: (a): Isoelastic preferences (b): Stone-Geary preferences

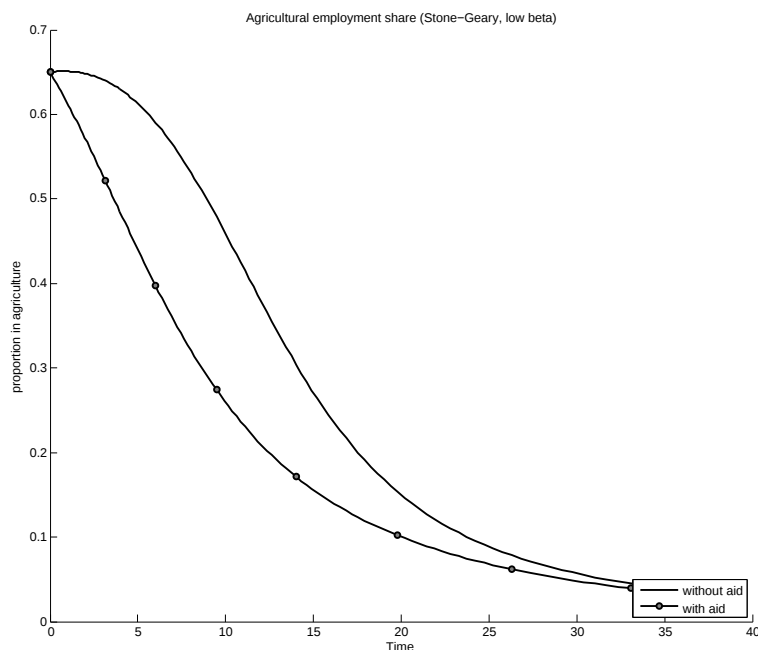
These figures show the paths of the agricultural employment share, with and without the transfer.

Under isoelastic utility, the transfer barely alters the growth rate, as shown in the first panel of figure 9. Under Stone-Geary preferences, the growth rate is low in the absence of transfers, but much higher when transfers are present, since investment is then undertaken to a greater extent. The difference in this case is marked; see the second panel of figure 9.

We can also see some interesting differences in convergence rates. Since we are considering economies some distance from the steady-state, the precise definition of the convergence rate matters. We define the convergence rate for $k(t)$ as $(dk/dt)/(k(t) - k^*)$ which corresponds to the first measure analyzed in Mathunjwa and Temple (2007). The convergence rates calculated from the simulations are shown for various cases in figure 10, again for the two-sector model. Note that convergence rates are higher in the presence of transfers, as in the one-sector case studied by Obstfeld (1999): moreover, convergence rates increase over time as the economy asymptotically approaches the one-sector Ramsey model. As would be expected, the convergence rates are much lower under Stone-Geary preferences than in the isoelastic case.

Next, we discuss the welfare effects which arise in the two-sector case. The two-sector model with isoelastic utility generates a HEV of 18%, and the model with Stone-Geary preferences a HEV of 24%. In each case, these welfare gains are almost identical to those in the one-sector models obtained earlier. In the two-sector model with Stone-

Figure 8: The agricultural employment share, Stone-Geary, low beta case

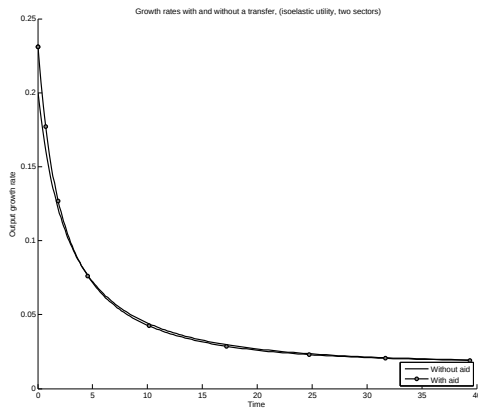


This figure shows the path of the agricultural employment share, with and without the transfer, under Stone-Geary preferences and with a low β .

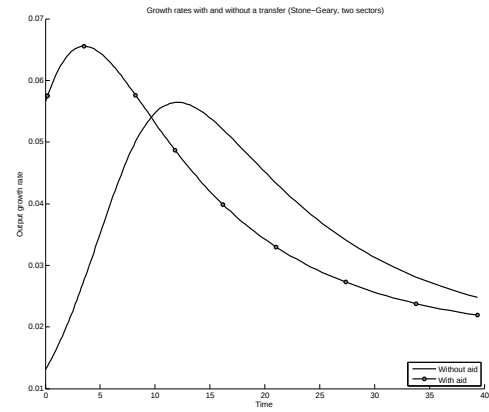
Geary preferences and a low β , the HEV is similar, at 23%. Hence, the welfare benefits of transfers do not vary greatly between the one-sector and two-sector models that we consider, even in versions of the model where transfers accelerate structural change.

It is clear that the effects of transfers on sectoral structure are highly sensitive to assumptions about technology parameters. If output-capital elasticities are similar across sectors, then capital accumulation makes little difference to sectoral structure. In that case, transfers do little to hasten structural transformation. But if the output-capital elasticities are some distance apart, and Stone-Geary preferences lead to initially low rates of investment, then transfers have a major effect on sectoral structure. In the Stone-Geary case, transfers also lead to much higher growth rates in the first few decades of the transitional dynamics.

This paper has taken a conventional view of household investment decisions, in which forgone consumption leads to the accumulation of physical capital. Larger effects of transfers might be found in models with a wider range of investment opportunities. For example, Bryan et al. (2014) consider the relationship between temporary



(a)



(b)

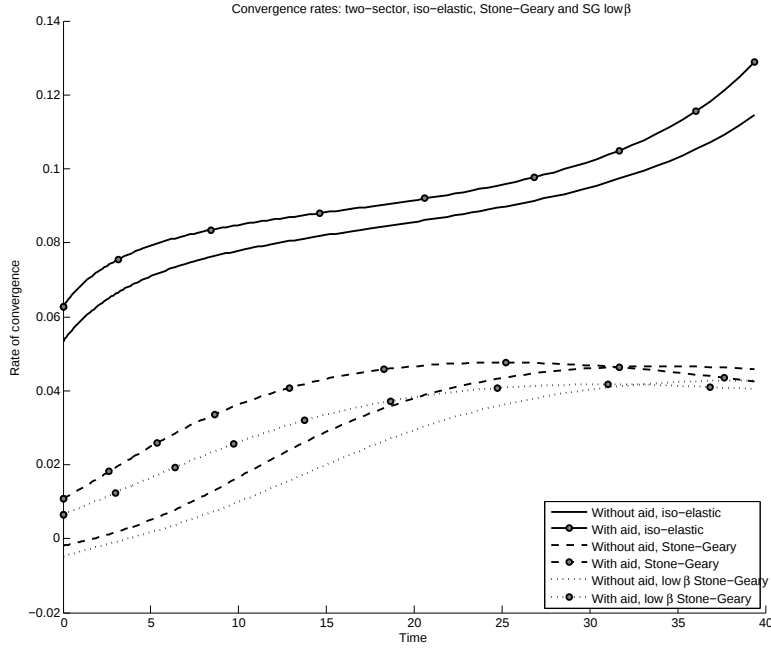
Figure 9: (a): Isoelastic preferences (b): Stone-Geary preferences

These figures show the growth rate, with and without transfers.

out-migration decisions and the proximity of households to a subsistence constraint. Allen (2013) considers occupational choice in a two-sector setting where subsistence constraints matter. A further possibility is that consumption could have a productive aspect, as in Steger (2000, 2002). He shows that, if consumption is associated with higher productivity or human capital accumulation — for example, because higher consumption is associated with better nutrition and health — then the effective intertemporal elasticity of substitution is lower in the early stages of a development process. In principle, this could reinforce the growth and welfare effects of transfers, in a similar way to Stone-Geary preferences in the analysis above.

Looking further afield, the effects of transfers could be rather different in models that embed ideas from behavioral economics, as Bryan et al. (2014, p. 1717) discuss. In principle, some of these ideas could be used to extend the analysis above. Hyperbolic discounting can be incorporated in the Ramsey model along the lines of Barro (1999). But it is also possible that more radical approaches should be considered. Bernard et al. (2014) present interesting evidence from a randomized trial that investment decisions, broadly interpreted, are related to aspirations.

Figure 10: Convergence rates, two sectors



This figure shows convergence rates for various cases

5 Conclusions

Our paper has investigated whether international transfers should be expected to spur economic transformation. We can summarize our findings as follows. In the models we have studied, cash transfers to households — perhaps arising from foreign aid, private charitable flows, or personal remittances — raise welfare. But under isoelastic utility, the effects on investment and growth are modest. This is the case even in a multi-sector setting, where the effects of transfers on investment and growth might have been expected to be larger. In this setting, there is little prospect that transfers will promote long-run growth and development. The underlying intuition is that, if the returns to investment were high, investment would have been undertaken even in the absence of transfers.

But this analysis also hints at the importance of preferences, and the intertemporal elasticity of substitution emerges as a key parameter. One way to obtain much larger growth effects is to adopt Stone-Geary preferences, and assume that average consump-

tion is close to a subsistence consumption threshold. In that case, the intertemporal elasticity of substitution is low at the beginning of the transitional dynamics, at least for some households. This leads to low rates of aggregate investment, even when the returns to capital are high, because the opportunity cost of investment is also high. In this case, transfers can be especially valuable and growth may be slow in their absence. We have also shown that, if transfers are to have a major effect on sectoral structure, a further condition is needed: there must be significant differences in output-capital elasticities across sectors.

Taken together, the findings point in one direction. When analysing the growth and welfare effects of transfers, the most important questions are not simply the time path taken by the returns to capital, the proportion of a transfer that is invested, or whether the poor have lower investment rates. A central question is whether aggregate investment is low in the early stages of the transition, despite a high marginal product of capital. If investment would have been undertaken in the absence of transfers, it is harder to make the case that transfers will hasten economic transformation. In that sense, the results in the paper formalize a long-standing critique of foreign aid programs, and indicate the circumstances in which it applies.

We have emphasized the role of subsistence constraints, as one force that holds back investment even when returns are high, and that makes transfers more effective. A further possibility is that transfers could be more readily transformative in more complex models, in which accumulation extends beyond physical capital. For example, allowing for investments in human capital or occupational choice would increase the scope for large effects. So would the idea that some forms of consumption in developing countries, such as improved nutrition and shelter, could influence future productivity. Hence, it seems important to consider the effects of transfers in dynamic models with a wider range of investment opportunities. This represents an interesting opportunity for further work.

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