RESEARCH ARTICLE

The Impact of Proportional Remittances on the Macroeconomy: Analysis from an Overlapping Generations Model for the Philippines

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Abstract: The discourse on micro-foundations linking microeconomic and macroeconomic principles to establish relationships in macroeconomic models have been increasing, one of which is through an Overlapping Generations Model. From its standard form, it has been extended to incorporate migration and remittances. We contribute to the discussion by introducing proportional remittances in the model and trace its effects on the trajectory of aggregate income, consumption, capital stock, and factor prices. Calibration results showed that increases in proportional remittances induce higher aggregate income, consumption, and capital accumulation paths, albeit varying degrees with respect to the elasticity of substitution between current and future consumption. That is, higher proportion of remittances accompanied by higher preferences for future consumption facilitate faster capital accumulation. We echo the need for greater interventions and assistance for migrant workers and their dependents, so that remittances continue to be an effective driver of long run economic growth and development.

Keywords: capital, labor migration, macroeconomy, overlapping generations model, remittances

JEL Classification: E21, E22, F24

Introduction

Scholarly discussion of macroeconomic analysis has evolved from the traditional Keynesian Macroeconomics towards micro-founded analysis where microeconomic models of individual behavior are combined to derive relationships between macroeconomic variables. According to Barro (1993) and Janssen (2006), micro-foundations, based on microeconomic behaviors of representative agents (i.e., households and firms), serve as basis of economic theory. For instance, according to Snowdon and Vane (2005), New Classical Macroeconomics has emerged to provide neoclassical microeconomic foundations for macroeconomic analysis. This is in contrast with New Keynesian Macroeconomics, whose micro-foundations are hinged on sticky prices and imperfect competition in developing macroeconomic models aligned with Keynesian ones. Palley (2004) provided a more detailed discussion on shifting economic paradigms from Keynesian onwards. Henceforth, studies using micro-foundations that link microeconomic and macroeconomic principles to establish aggregate relationships in macroeconomic models have expanded (Locatelli et al., 2021; Barney & Felin, 2013).

The evolution of economic thoughts motivated us to contribute to the discussion on the macroeconomic impacts of remittances using micro-founded analysis as opposed to the econometric analysis done by most studies. This is of relevance for the Philippines because of its status as one of the global suppliers of manpower (Mendoza, 2015) and one of the largest remittance destinations (Ochave, 2020). Because the country considers remittances as one of its economic pillars, we cannot undermine its impacts on the macroeconomy. In fact, time series data from the Bangko Sentral ng Pilipinas (BSP1) indicated sustained remittances inflows from its migrant workers, known as Overseas Filipino Workers (OFWs) that have "augmented domestic incomes to support consumption and more recently capital formation with the Filipino middle class ushering in an investment boom" (Mapa, 2020, para. 1), and has contributed to strong macroeconomic fundamentals (Bahadir et al., 2018; Bayangos & Jansen, 2009; Borgne, 2009). Such remittances facilitated the country's growth and development track (Meyer & Shera, 2017). Interestingly, remittances from OFWs have mostly demonstrated countercyclicality (Sayeh & Chami, 2020; Belen, 2015; Borgne, 2009). Despite the damaging impacts of the coronavirus (COVID-19) pandemic, remittance inflows to the Philippines have demonstrated resiliency (Noble, 2021; Gamboa, 2020). In 2019, data from BSP reported historically high remittance inflows at USD 30.13 billion, which declined to USD 29.90 billion in 2020 as OFWs were affected by pandemic-related restrictions. However, in the first half of 2021, cash remittances grew by 6.4%. This trend continued until the first quarter of 2022 wherein "money sent home by OFWs rose by 3.2% in March, reflecting improved economic conditions in many host countries as pandemic restrictions eased" (Ta-asan, 2022, para 1) as vaccination proceeded and infections declined. Also, being a huge source of remittances, the United States' strong recovery contributed to improved remittance flows (Noble, 2021). Remittances are seen to recover as soon as the pandemic ends (Cuaresma, 2021).

As OFWs continued to remit, it posed microeconomic and macroeconomic implications. From a microeconomic perspective, remittances continued to enhance domestic consumption on durable and non-durable goods (Ang et al., 2009) and to finance investments on real assets and financial capital that serve as insurance against income shocks (Teele et al., 2009; Quisumbing et al., 2008; Yang & Choi, 2007). From a macroeconomic perspective, remittances were seen to aid macroeconomic fundamentals given its 8.5% contribution to the economy's Gross Domestic Product (GDP) in 2019 (Mapa, 2020) and

these surpassed overseas development assistance and foreign direct investment in terms of economic contributions (Barne & Pirlea, 2019). Thus, Rivera (2013, 2011), Dash (2020) and Ait Benhamou and Cassin (2021) also argued that remittances influence savings and capital accumulation. That is, large volume of remittances received by the Philippines poses certain microeconomic and macroeconomic implications that impact aggregate income, capital accumulation, and consumption. This is best illustrated by a microfounded macroeconomic approach. This motivated us to implement a theoretical modeling approach, particularly an Overlapping Generations (OLG) Model, that incorporates remittances, instead of an empirical one. To do this, we need to simulate the macroeconomic impacts of remittances.

While most studies on remittances in the Philippines used secondary empirical data, we take the track of theoretically probing how remittances impact aggregate income, consumption, capital accumulation, and factor prices as gleaned from the findings of Ait Benhamou and Cassin (2021), Ajefu and Ogebe (2021), Dash (2020), Delpierre and Verheyden (2014), Rivera (2013, 2011), and Quinn (2005). While most studies represented remittances as fixed and exogenous, we express it as a proportion of the migrant worker's destination economy's (i.e., host or foreign economy) aggregate income, following one of the metrics used by the World Bank² and appealing to the discussions of Ang et al. (2009) and Bayangos and Jansen (2009). Using proportional remittances would allow for the analysis of any form of income that is affected by aggregate income (e.g., government transfers, income shock, subsidies). This is not captured when remittances are expressed as fixed and exogenous.

Thus, we pose the research question: how do proportional remittances affect the Philippines' aggregate income, consumption, capital accumulation, and factor prices? In addressing this, we set the following objectives:

- 1. To introduce proportional remittances in a standard OLG model that will play a role in the utility maximizing choice of a representative household between current and future consumption; and
- 2. To determine the impact of proportional remittances on aggregate income, consumption, capital accumulation, and factor prices.

3. To provide policy directions in managing remittances given its economic effects.

While other studies focused on the impacts of remittances on macroeconomic variables using econometric methodologies, we focus on its theoretical impact on the macroeconomy through an OLG model. We augment existing empirical results on the impacts of remittances. Our study also augments the baseline theoretical model of Rivera (2022) by extending it to more closely approximate reality. Our approach on how remittances enter the equation allows for a theoretical discussion on the dynamics of remittances, specifically proportional remittances, with the paths of macroeconomic variables above the usual empirical approaches. Ultimately, policies directions in managing remittances would have both empirical and theoretical foundations.

The Discourse on Migration and Remittances The Impact of Remittances on the Macroeconomy

Scholarly literature has discussed the developmental role of remittances (Navita & Pal, 2020; Tullao Jr. & Cabuay, 2016; Reyes et al., 2014; Tullao Jr. & Rivera, 2009; Ang et al., 2009). Moreover, social implications of remittances (e.g., *Dutch Disease*, brain drain, culture of dependency, excessive consumption) have also been underscored (Ratha, 2020; Sutradhar, 2020; Bredtmann et al., 2019; Amuedo-Dorantes, 2014; Acosta et al., 2009; Ducanes & Abella, 2008; Tuaño-Amador et al., 2007; Tullao Jr. et al., 2007; Bourdet & Falck, 2006; Cabegin, 2006; Loser et al., 2006; Amuedo-Dorantes & Pozo, 2004; Rodriguez & Tiongson, 2001). See Rivera and Tullao Jr. (2020, p. 310) for a detailed discussion of remittances' developmental impacts.

 Table 1. Selected Literature on the Effects of Remittances on the Macroeconomy

Author	Methodology	Locale	Key Findings
Chami et al. (2003)	Panel methods	Various	• Remittances negatively affects economic growth.
Cáceres and Saca (2006)	Vector autoregression (VAR)	El Salvador	• Remittances decreases economic activity, international reserves, and money supply but it increases interest rate, imports, and consumer prices.
Pernia (2006)	Econometric analysis	the Philippines	• Remittances are good for regional development, but overall increases in regional incomes do not benefit low income households as much as the upper income.
Chami et al. (2008)	Literature review	Various	• Remittances enhance investment in physical capita; have a positive impact on economic growth through its effect on the recipient economy's financial system; can result to the <i>Dutch disease</i> .
Bayangos and Jansen (2009)	Dynamic structural quarterly macroeconometric model	the Philippines	• Remittances positively impact aggregate demand but negatively impacts exchange rate appreciation.
Berthomieu and Tykhonenko (2009)	Iterative Bayesian procedure	MENA and Mediterranean economies	• Not all economies revealed positive impact of remittances on growth.
Borgne (2009)	Literature review	the Philippines	• Remittances boost private consumption, foreign exchange reserves, current account, and deposits in the financial system.
Barbarito (2011)	Ordinary least squares (OLS), Instrumental variable – 2 stage least squares (IV-2SLS), and IV – Generalized method of moments (GMM).	Bangladesh	• Growth effects of remittances are negative at first but becomes positive at a later stage; positively affect per capita GDP growth when the complementarity between remittances and financial development is included in the analysis.

Table 1 continue...

Author	Methodology	Locale	Key Findings
Narayan et al. (2011)	Arellano and Bond panel dynamic estimator; Arellano and Bover and Blundell and Bond system GMM	54 developing economies	Remittances generate inflation, which becomes more evident in the long run.
Singh et al. (2011)	Regression	Sub-Saharan Africa	• Remittances are countercyclical; affect growth negatively but not for economies with well-functioning domestic institutions.
Bayangos (2012)	Simulation from a complete macro econometric model	the Philippines	• Remittances increase consumption, investment, labor productivity and economic growth; increases in remittances lead to changes in economic structure and labor market.
Jansen et al. (2012)	Stochastic limited participation model	Various	• Remittances increase inflation, consumption, and leisure; remittance shocks create prolonged decline in GDP, which only diminishes when remittances are a larger percentage of GDP, fraction of remittances directed towards investment increases, or fraction of labor income that remittances represent is reduced.
Seriño (2012)	Cointegration Analysis	the Philippines	• Remittances negatively affect aggregate income in the short run but positively in the long run.
Sicat (2012)	Literature Review	the Philippines	• Remittances positively and significantly contribute to the economy's foreign exchange earnings; support the consumption and investment of recipient households; produce favorable impacts on the economy's balance of payments (BOP)
Khan and Islam (2013)	VAR	Bangladesh	• A 1% increase in remittances inflows increases inflation rate by 2.48% in the long run; no significant relationship is evident between remittances and inflation in the short-run.
Roy and Rahman (2014)	Vector Error Correction Model (VECM)	Bangladesh	Remittances generate inflationary pressures.
Rivera (2013, 2011)	Overlapping Generations (OLG) model	the Philippines	• Taxing remittances enables an economy to achieve higher steady state capital stock and aggregate income paths at the expense of lower future consumption with habit formation, if government will not exhaust revenues on one generation.
Baas and Melzer (2016)	Dynamic open-economy general equilibrium model with altruistic households	Germany	• Remittance outflows create depreciating effect on the real exchange rate and provide incentives to reallocate resources from non-tradable to tradable goods sectors (i.e., <i>Dutch disease</i>).
Bouoiyour et al. (2016)	Empirical Mode Decomposition (EMD)	Tunisia	• Remittances impact growth negatively and consumption positively; remittances' investment effect becomes negative and weak in the short- and medium-run; strongly and positively impact growth and consumption in the long run.

Table 1 continue...

Author	Methodology	Locale	Key Findings
Khurshid et al., 2016	System GMM and bootstrap panel Granger causality approach	58 countries from low, lower-middle and middle-income groups	• Remittances have a negative and significant impact on inflation in low and lower- middle income countries but positive for the middle-income group; remittances used for consumption and savings generate inflation only in low and lower-middle income groups; have a strong impact on prices in lower-middle income economies.
Oshaibat and Majali (2016)	Non-linear regression	Jordan	• Remittances have long-term effects on stock returns through its impact on aggregate demand and economic growth.
Atiya and Jawaid (2017)	OLS and Causality analysis	Pakistan	• Remittances have positive impact on stock market index.
Bahadir et al. (2018)	Open economy Dynamic Stochastic General Equilibrium (DSGE) model	the Philippines	• Remittances are contractionary when it accrues to hand-to-mouth wage earners; and expansionary when it accrues to credit-constrained entrepreneurs.
Das and Chowdhury (2019)	Autoregressive Distributed Lag (ARDL)	Bangladesh	• The effects of remittances as ratio of GDP on consumption and investment rates are no more than 86% to 87%.
Mendoza-Cota and Torres-Preciado (2019)	Spatial dynamic space- time panel model	Mexico	• Remittances positively affects economic growth of recipient economies.
Lim et al. (2020)	Simple macro-dynamic model of two small open economies	A host advanced economy (i.e., Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) and a labor-exporting, developing economy (i.e., Bangladesh)	• Provided a framework for assessing efforts advanced by developing economies towards their domestic economic development.
Rivera and Tullao Jr. (2020)	VAR	the Philippines	• Remittances are not necessarily inflationary.
Taasim (2021)	Nonlinear ARDL approach	Malaysia	• Remittances have short-run and long-run effects on capital accumulation; can increase capital accumulation; can form a significant source of external capital and investment for developing economies, which promote economic development.
Rivera (2022)	OLG	the Philippines	• Remittances facilitate growth of steady- state consumption, of remittance-recipient households,aggregate income, and capital accumulation.

Note: Arranged from earliest to latest.

Because we want to explicate the impacts proportional remittances on the macroeconomy, we focus our discussion on what existing literature has established on the effects that remittances, in general, have on the macroeconomy. Table 1 presents the studies highlighting the effects of remittances on the macroeconomy.

Theoretical Approach

The OLG model was first formulated in 1947 to depict a pure-exchange economy³ (Aliprantis & Burkinshaw, 1990; Samuelson, 1958). Then, Diamond (1965) added an aggregate neoclassical production. The extension continued when Galor (1992) transformed it into a two-sector model; and Galor and Weil (2000, 1996) introduced endogenous fertility. Now, it has become a dominating analytical framework of macroeconomic dynamics and economic growth because of the innovation it introduced to the Ramsey-Cass-Koopmans neoclassical growth model (see Acemoglu, 2009). Instead of assuming that individuals live infinitely, the OLG model assumed that individuals live a finite length of time that is long enough to overlap with at least one period of another individual's life (see Diamond, 1965).

Because of OLG's flexibility to adjustments, various studies have incorporated realistic descriptions of society, one of which is migration possibilities with remittances. For instance, on welfare, Crettez et al. (1996) constructed a 2-economy migration model with population having different time preferences to investigate the implications of international labor migration on steady state welfare. Thibault (2001) also developed an OLG model for an economy with agents having elastic labor supply, differing degrees of altruism, and varying rates of time preference to trace the influence of labor immigration on bequest motive, labor supply, and long-run welfare.

On steady state capital, Rivera (2013, 2011) developed a two-period life cycle model with migration and remittances, savings, and taxation. Simulation results revealed that taxing remittances allows an economy to achieve higher steady state capital stock and aggregate income paths but with lower future consumption. Rivera (2022) recalibrated the earlier model using a different utility function, parameter values, and remittance-specification. Calibration results showed the power of remittances in stimulating steadystate consumption, income, and capital accumulation. Meanwhile, Chaabane and Gaumont (2015) developed a 2-economy and 3-period OLG model with education to study the impact on international migration on steady state capital per capita. They found that differences in education generates differences in per capita steady state capital, creating price differentials that prompts illegal migration. Likewise, Simon (2013) created two OLG models that encompassed immigration. The first investigated welfare effects of an abrupt variation in the number of immigrants on the host economy for various population generations. The second allowed for variation in age structure of incoming migrants to determine its impact on pension system and capital accumulation. In addition, Dacuycuy and Lim (2014) introduced human capital and savings in an OLG economy. They found that migration possibilities may increase human capital formation.

On the macroeconomy, Destrée et al. (2021) developed an OLG model to study the impact of migration and remittances, with debt constraints for the representative agent to finance education. They found that remittances generate multiple equilibria, decrease the agents' incentive to save, reinforce endogenous financial constraints, and improve economic growth.

Remittances on Consumption, Capital Accumulation, and Aggregate Income

Regardless of approach taken, scholarly literature touched on the effects of migration and remittances on aggregate income, consumption, capital accumulation, and factor prices (i.e., wages and interest). Figure 1 illustrates how the impacts of remittances are channeled. Note that solid lines indicate direct linkage between the variables as established by literature. Meanwhile, broken lines indicate that while a direct linkage between the variables also exist as established by literature, it can also be mediated by the variables in between them. For instance, while remittances do impact capital stock accumulation, consumption, and aggregate income, it is also plausible that the effect of remittances on aggregate income is mediated by capital stock accumulation and consumption. Similarly, while consumption does impact aggregate income, it is also reasonable to say that consumption also explains the effect of capital accumulation on aggregate income. These systemic effects are reflected in solving an OLG model involving such variables.



Figure 1. Literature Map

On consumption, solving the utility maximization problem of a representative household subject to an intertemporal budget constraint determines their optimal consumption when young and when old. Together with domestically sourced income, remittances provide additional funds to spend on both consumption and investment (Ahmed & Mughal, 2015; Rivera, 2013; Cañas et al., 2010; Medina & Cardona, 2010; Castaldo & Reilly, 2007). Here, studies distinguish domestically sourced income from remittance income. While remittances will augment household income regardless of source, it is imperative to contextualize the characteristic of this additional income. Meanwhile, for Rodríguez and Tiongson (2001), Acosta et al. (2009), and Cañas (2010), remittances increase leisure time of recipient households that cuts labor supply, diminish their domestic income-generating capabilities, and reduce their potential purchasing power. Worse, if migration was debt-financed, boosted consumption and savings are deferred until debt is fully settled (Baldé, 2010). These have ramifications on aggregate income and capital accumulation.

On capital accumulation, through the investment motive of remittance-sending (Tullao Jr. & Cabuay,

2016), remittances can fund recipient households' investments and wealth expansion (Osili, 2007). This transpires when migrant workers earning more will remit more, of which a substantial share will be apportioned for savings and capital accumulation (Baldé, 2011). However, savings from remittances is reduced when recipient household's size increases, accompanied by a premium on current consumption (Rivera, 2013). Alternatively, remittances may either decrease the need to save due to greater consumption possibilities; or increase the demand for savings to accumulate future wealth (Ajefu & Ogebe, 2021; Quinn, 2005). Such competing motivations to use remittances create uncertainties that disturb the dynamics between consumption and savings (Prívara & Trnovsky, 2021; Delpierre & Verheyden, 2014). We can construe that the impact of remittances on aggregate income is through savings and capital accumulation.

On aggregate income, holding preference towards current or future consumption constant, remittances generally enhance consumption, capital accumulation, and aggregate income for both time periods (Meyer & Shera, 2017; Amuedo-Dorantes, 2014; Cañas et al., 2010; Ang et al., 2009). Likewise, whether remittances behave pro-cyclically (Bayangos & Jansen, 2009; Dakila & Claveria, 2007; Tuaño-Amador et al., 2007) or countercyclically (Amuedo-Dorantes, 2014; Yang, 2008; Yang & Choi, 2007; Burgess & Haksar, 2005), its impact on the macroeconomy is dependent on how it is utilized by its recipient households (Baldé, 2011; Cañas et al., 2010; Ang, n.d.).

On factor prices, Cañas et al. (2010), Kim (2012), and Gnangnon (2020) argued that wages in the migrant's home economy tend to increase as remittances increase. This is because migration alters the wage structure in the sending economy by driving higher wages for those left behind through higher wages. Meanwhile, the effect of remittances on interest rate is ambiguous (Quinn, 2005), which depends on how recipients spend it on current and future consumption. That is, a consumption pattern that allows for greater savings would drive faster capital accumulation that results to lower interest rates (Aizenman et al., 2017; Bofinger & Ries, 2017).

Research Gap

From Table 1, most studies have been empirical with some theoretical approaches that opened opportunities for extensions. While conceptual and empirical studies have traced the bi-directional links between remittances and the macroeconomy; and theoretical studies probed the inclusion of migration possibilities, incidence of migration, and composition of labor, there is value in examining further remittances (i.e., the financial component of migration). In continuing the track of Rivera (2022, 2013, 2011), we contribute to theoretical knowledge in explicating the macroeconomic impacts of remittances through various ways on how remittances enter the model. Using proportional remittances endogenizes remittances rather than fixing it. This is because, remittances are affected by various factors (Rivera & Tullao Jr., 2020; Navita & Pal, 2020; Tullao Jr. & Cabuay, 2016). We also introduce some complexity in the model that may spawn alternate and better evaluations that improve understanding of the macroeconomic impacts of remittances.

Overlapping Generations Model

In addressing our research problem and objectives, we use the standard micro-based macro-model analysis developed by Diamond (1965), an OLG model under perfect foresight and perfect competition that evaluates the impacts of the consumption-savings behavior of representative households, taking into consideration life-cycle periods that overlap with one another.

In continuing the work of Rivera (2022, 2013, 2011), we introduced modifications on how remittances enter the intertemporal budget constraint in the form of an additional income. Instead of expressing it as fixed and exogenous, we set it as a proportion of the foreign economy's aggregate income in the first period only. We chose to take off from the approach of Rivera (2022, 2013, 2011) because additional variables in the OLG model were added one-by-one in a step-by-step manner. Hence, it makes it easier to track where modifications occurred and where innovations to the model can be feasibly done.

Likewise, following Diamond (1965), we also assume that income is generated only in the first period (i.e., individuals only work during the young phase of their lives). Second-period consumption is financed by earnings from the capital market generated by consumption-savings-investment decisions. Hence, in simulating our OLG model with remittances and choosing parameter values to calibrate the model, we probe on its effects on aggregate income, consumption, capital accumulation, and factor prices. We are also able to gauge the comparative statics when parameter values change.

In solving and calibrating our OLG model, we follow the Gauss-Seidel method suggested by Auerbach and Kotlikoff (1987). Given specific parameterization, we can determine the direction and paths of our macroeconomic variables of interest. As implemented by Rivera (2022, 2013, 2011), 10 to 20 or even 30 iterations are recommended to achieve steady state convergence.

We deem the OLG model as the suitable theoretical approach to simulate the present- and future-oriented behavior of representative households. Because they live within finite time periods that overlap at one point in time, they carry endowment and savings towards future consumption. Moreover, as discussed earlier, the OLG model addressed the criticism of neoclassical growth models regarding its assumption of representative agents living infinitely.

Baseline Model

We specify in Equation 1 the utility function of a representative household (i.e., Cobb-Douglas) consisting of two time periods wherein the first is when young (y) and the second is when old (o). Moreover, the $\beta \in [0,1]$ indicates the proportion of household intertemporal budget on current (t) consumption and the residual on future (t + 1) consumption.

$$U_t = C_{yt}^{\beta} C_{o(t+1)}^{1-\beta} \tag{1}$$

Meanwhile, we specify in Equation 2 the production function of the Philippines (i.e., also Cobb-Douglas) comprising of capital (K) and labor (L).

$$Y_t = AK_t^{\alpha} L_t^{1-\alpha} \tag{2}$$

We set our production function to exhibit constant returns to scale. Hence, the $\alpha \in [0,1]$ indicates the share of income received by owners of capital and the residual is the share of income received by labor. Likewise, the index of overall productivity (i.e., total factor productivity or technical change) in the economy is denoted by A, for all time periods. Unlike standard OLG models that set $L_t = 1$ by assumption that population is fixed for all time periods, we allow population to grow at a given rate, ρ , wherein $L_t = (1 + \rho) L_{t-1}$ where ρ is the replacement rate (i.e., population growth rate) determined by the difference between birth rate and death rate. Incorporating migration possibilities, we add a parameter, δ , to indicate the net migration rate, which is the number of immigrants less the number of emigrants over a period, divided by the person-years lived by the population of the receiving economy over that period (expressed as net number of migrants per 1,000 population). Hence, we set $L_t = (1 + \rho - \delta) L_{t-1}$, where $(1 + \rho - \delta)$ is the impact multiplier of labor.

Meanwhile, Equation 3 represents the representative household's intertemporal budget constraint without remittances. Following the assumption of Diamond (1965), each individual receives a fixed endowment of a good at birth. This endowment of goods can also be thought of as an endowment of labor that the individual uses to work and create a real income equal to the value of good produced. Under this framework, individuals only work during the young phase of their lives. Second-period consumption is financed by earnings from the capital market generated by consumptionsavings-investment decisions.

$$C_{yt} + \frac{C_{o(t+1)}}{1+r_{1}} = w_t \tag{3}$$

Solving the utility maximization problem subject to the inter-temporal budget constraint will yield equilibrium Marshallian consumption functions when young, βw_t and when old, $(1 - \beta)(1 + r_{t+1})w_t$.

Solving for the marginal products of labor and capital, Equations 4 and 5 represent factor prices, namely wages and interest rate, respectively.

$$w_t = (1 - \alpha) A K_t^{\alpha} L_t^{-\alpha} \tag{4}$$

$$r_t = \alpha A K_t^{\alpha - 1} L_t^{1 - \alpha} \tag{5}$$

Under perfect competition, equilibrium condition is stated by Equation 6 that will solve for the law of motion of capital shown by Equation 7.

$$S_t = w_t - C_{yt} = K_{t+1} {(6)}$$

$$K_{t+1} = (1 - \beta) [(1 - \alpha) A K_t^{\alpha} L_t^{-\alpha}]$$
(7)

Under perfect foresight and rational expectations, we know that $K_{t+1} = K_t$ at the steady state. Thus, Equation 8 represents the steady state equation for capital, which is a closed form solution. Note that a closed form solution solves a given problem in terms of functions and mathematical operations from a given generally-accepted set (Stover & Weisstein, n.d.). That is, we are able to isolate *K* and express it as a function of parameters only. Hence, a closed form solution provides an exact answer compared to a non-closed form solution, which requires high computational powers through repetitive and successive iterations.

$$\widehat{K} = [(1-\beta)(1-\alpha)AL_t^{-\alpha}]^{\frac{1}{1-\alpha}}$$
(8)

Introducing Proportional Remittances

In addressing our second research objective, we incorporate remittances in the first period, denoted by Φ_i , which is added to domestic income, w_i . Equation 9 indicates the intertemporal budget constraint with remittances.

$$C_{yt} + \frac{C_{o(t+1)}}{1 + r_{t+1}} = w_t + \Phi_t \tag{9}$$

Instead of setting remittances as fixed and exogenous, we express it as a proportion of aggregate income of the migrant worker's destination economy, denoted by $\Phi_t = \theta Y_t^f$ where $\theta \in [0,1]$. Here, we assume that the aggregate income of the foreign economy is higher than the aggregate income of the Philippines in the previous period by a factor of λ , which we arbitrarily peg at 50 percent. In choosing this factor, we appeal to the deployment data from the Philippine Overseas Employment Administration (POEA) (https://www.poea.gov.ph/) wherein most of the OFWs are deployed in developed economies, construed to have a higher GDP than the Philippines. Hence, we can restate remittances as $\Phi_t = \theta(1 + \lambda)Y_{t-1}$. Technically, through this approach, we have endogenized remittances as emphasized by Delpierre and Verheyden (2014). Of course, this OLG model is open to be extended into a two-economy model wherein the equilibrium of the foreign economy is also solved. However, because our objective is to probe on the response of macroeconomic variables on varying proportions of remittances, we digress from this approach.

Furthermore, because of this modification, anything added to w_t can represent all sorts of additional income to the household or any exogenous income shock, one-time transfer, or subsidy, which is not limited to remittances. Likewise, our expression of proportional remittances can come in the form of transfers that increase with aggregate income. As such, our model can be generalized to capture the effects of any additional household income in the first period. While this is the case, we contextualize this additional income in the form of remittances.

While using the same Cobb-Douglas utility and production functions above, we specify in Equation 10 the intertemporal budget constraint with proportional remittances in the first period.

Representative Household Intertemporal
Budget Constraint (With Proportional
Remittances)
$$C_{yt} + \frac{C_{o(t+1)}}{1 + r_{t+1}} = w_t + \Phi_t$$
(10)

Solving the utility maximization problem with proportional remittances, we derive the following Marshallian consumption functions:

Marshallian Consumption Function
(When Young, y),
$$C_{yt}$$

$$\beta(w_t + \theta Y_t^f)$$
(11)
Marshallian Consumption Function

Marshallian Consumption Function (When Old, o), $C_{o(t+1)}$

$$(1-\beta)(1+r_{t+1})(w_t+\theta Y_t^f)$$
 (12)

Restating Equation 6 to Equation 13, we derive the law of motion of capital with proportional remittances as seen in Equation 14. Given the assumption of perfect foresight and rational expectations denoted by $K_{t+1} = K_t$ and simplifying further, we have Equation 15, a closed form solution. When $\theta = 0$ (i.e., no remittances), Equation 13 can be reduced to Equation 8.

Equilibrium condition under
perfect competition
$$S_{t} = \left(w_{t} + \theta Y_{t}^{f}\right) - C_{yt} = K_{t+1}$$
(13)
Law of Motion of Capital
$$K_{t+1} = (1 - \beta)[(1 - \alpha)AK_{t}^{\alpha}L_{t}^{-\alpha}] + \theta Y_{t}^{f}$$
(14)
Law of Motion of Capital
$$\widehat{K} = \{(1 - \beta)(1 - \alpha)AL_{t}^{-\alpha} + \theta(1 + \lambda)AL_{t-1}^{1-\alpha}\}^{\frac{1}{1-\alpha}}$$
(15)

We have seen that using proportional remittances would also yield a closed form solution for the law of motion of capital, such as in the absence of remittances. From our mathematical specification, we can construe that a closed form solution is not feasible when remittances are expressed as fixed and exogenous. Our series

of iterations and calibration technique will begin at the steady state at t = 0, and will determine if paths converge to a steady state solution.

Selection of Parameter Values

In calibrating our model through a numerical simulation approach, we need to find a set of model parameters that can provide a good baseline description of the system behavior, and that can be achieved by assessing model predictions with actual measurements. To do this, we assign parameter values to derive exact numerical equilibrium solution for the Philippine economy, given our formulations above. Our choice of parameter values will allow for the simulation of our OLG model. While parameter values can be altered, our initial values can trace the relationship we are investigating. Table 2 summarizes our assumed parameter values.

Parameters	Description	Value	Remarks	
β	Elasticity of substitution between consumption when young and old	0.2 to 0.8 in increments of 0.2	Arbitrary, we eliminate the	
$1-\beta$	Elasticity of substitution between consumption when old and young	0.8 to 0.2 in decrements of 0.2	possibility of 0.0 and 1.0.	
α	Output elasticity of capital	0.4	Being a labor-abundant and intensive	
$1 - \alpha$	Output elasticity of labor	0.6	economy, elasticity of labor for the Philippines should be higher than that of capital (Patalinghug, 2019).	
A	Total factor productivity or technical change	1.0076	Federal Reserve Bank of St. Louis (2019) *	
K	Capital input	Ŕ	Assume the economy starts at steady state.	
L	Labor input	1.0	Normalized to 1 at $t = 0$.	
ρ -	Crude birth rate	20.166 per 1,000 population	World Bank (2019) **	
	Crude death rate	5.92 per 1,000 population	World Bank (2019) ***	
	Replacement rate	14.246 per 1,000 population	Computed from the difference between crude birth rate and crude death rate.	
δ	Net Migration Rate	-0.626 per 1,000 population	Macrotrends (2019) ****	
Y_t^f	Aggregate income of foreign economy	Higher by a 50% of home economy's aggregate income at $t - 1$	Foreign economy should have higher aggregate output than home economy.	
θ	Proportion of income in the form of remittances	0.05 to 0.2 in increments of 0.05.	Arbitrary.	

 Table 2. Parameter Values

* https://fred.stlouisfed.org/series/RTFPNAPHA632NRUG.

** https://data.worldbank.org/indicator/SP.DYN.CBRT.IN?locations=PH.

*** https://data.worldbank.org/indicator/SP.DYN.CDRT.IN?locations=PH.

**** https://www.macrotrends.net/countries/PHL/philippines/net-migration.





The Impact of Proportional Remittances on the Macroeconomy







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Plot of Calibrated Values of K_t





Plot of Calibrated Values of w_t



Results and Discussion

Calibrated steady state results on the impact of proportional remittances, q, on consumption when young (i.e., current consumption), consumption when old (i.e., future consumption), aggregate income, capital accumulation, interest rates, and wages, are plotted in Figure 2. The numerical simulations have been generated using the Gauss-Seidel method iterating for 30 time periods from the parameter values in Table 2.

The first row in Figure 2 plots the path of consumption when young. As expected, we can see that as the proportion of remittances increase, it also results to an increase in current consumption, consistent with the findings of Castaldo and Reilly (2007), Cañas et al. (2010), Medina and Cardona (2010), Rivera (2013), and Ahmed and Mughal (2015), among others. We also need to note that as the proportion of household intertemporal budget on current consumption increases, together with increases in the proportion of remittances, it causes steep increases in current consumption. Here, we can visualize the power of remittances in boosting consumption.

The second row in Figure 2 plots the path of consumption when old. As a consequence of the results in the first panel, we can see the reallocation of consumption when young and when old relative to the amount of proportional remittances received and the preference for current or future consumption. At lower values of β , we can see wider gaps between the paths of future consumption at varying values of θ . At higher values of β , we can see narrow gaps between the paths of future consumption at varying values of θ . Here, we can visualize how remittances can either be a powerful or an inadequate means to facilitate a second period of greater consumption. This is supportive of the argument of Ang (n.d.), Cañas et al. (2010), and Baldé (2011) that the impact of remittances is dependent on how it is utilized by its recipients.

The third row in Figure 2 plots the path of aggregate income. We can see how high and steep aggregate income paths can be at lower values of β , which are reinforced by rising value of θ , compared to how low and gradual aggregate income paths are higher values of β despite rising value of θ . While the increase in aggregate income paths given increasing proportional remittances are expected, consistent with Ang et al. (2009), Cañas et al. (2010), Amuedo-Dorantes (2014), and Meyer and Shera (2017), we can see how critical the use of remittances are in the current period--it can chart the path of aggregate income. This result makes the argument of Ang (n.d.), Cañas et al. (2010), and Baldé (2011), that the impact of remittances on aggregate income is dependent on how it is utilized by its recipients, more pronounced.

The fourth row in Figure 2 plots the path of capital accumulation. Note that the generated paths are a consequence of consumption-saving behavior, which impacts the aggregate income paths. However, it is noteworthy to pay attention to the wide gaps between capital accumulation paths while holding β constant and allowing θ to increase. While it is trivial to say that higher values of β decrease the amount of steady state capital for the economy because of higher preferences of representative households to consume when young, which corresponds to lower savings when young, we highlight that the increase in proportional remittances allows for higher capital accumulation paths at any value of β . Here, we can see the power of remittances to facilitate higher capital accumulation for an economy. Given preference for current rather than future consumption, even if proportional remittances are increasing, capital accumulation path is relatively lower, resulting to lower aggregate income paths than when preference is on future rather than current consumption. Hence, as a productive input, lower capital stock accumulation cannot drive much aggregate income growth. Because the impact of proportional remittances on aggregate income paths can also be channeled through consumptionsavings and capital accumulation, we cannot anymore overemphasize the importance of using remittances towards savings, wealth accumulation, and greater future consumption (Ajefu & Ogebe, 2021; Prívara & Trnovsky, 2021; Delpierre & Verheyden, 2014; Quinn, 2005).

The fifth row in Figure 2 plots the path of interest rate. We can observe an inverse relationship between capital accumulation paths and interest rate. States of the world with higher capital accumulation path have relatively lower interest rates and vise-versa. This result sheds light on the findings of Quinn (2005), Aizenman et al. (2017) and Bofinger and Ries (2017), wherein depending on how recipient households spend remittances on current and future consumption, a consumption pattern that permits greater savings would facilitate faster capital accumulation that results to lower interest rates. That is, higher savings results to higher capital accumulation. As capital accumulates, it becomes more abundant, putting a downward pressure on its price. Therefore, the effect of remittances on interest rate is not direct but is mediated by consumption and capital stock.

Finally, the last row in Figure 2 plots the path of wages. We can see that across all values of β and θ , the general trajectory of wages is decreasing. Moreover, higher proportional remittances drive higher wages, which is consistent with the findings of Cañas et al. (2010), Kim (2012), and Gnangnon (2020). That is, wages in the migrant's home economy move alongside remittances. This is based on the argument that migration can alter the wage structure in the sending economy by driving higher wages for those left behind through higher wages. Amuedo-Dorantes (2014) explained this trend. Because "remittances may ease budget constraints, raise reservation wages, and through an income effect, reduce the employment likelihood and hours worked by individuals receiving remittances. However, remittances might also be accompanied by a substitution effect if household members have an incentive to cut back on their labor supply in order to continue to receive the non-labor income flows, which is a distortion of household labor supply decisions" (para. 8). This reduced willingness to supply labor causes wages to increase.

Conclusions

We have established from literature that remittances pose both positive and negative impacts to the macroeconomy. We have also illustrated from our simulation of an OLG model with migration and remittances, the critical role of representative household's consumption-savings behavior and their productive use of additional income, particularly remittances, in driving greater capital accumulation and aggregate income paths. Prior to the success of temporary labor migration in the Philippines, a representative household mostly earned income domestically through salaries and wages. With the rising demand for migrant workers in developed economies coupled by lucrative earning opportunities abroad, it induced the culture of labor migration among many Filipino households. Eventually, households have enjoyed greater consumption and/or investment possibilities from remittance income sent by family members who are migrant workers. By introducing proportional remittances to the standard OLG model, we have endogenized it to probe on the power of remittances in charting the trajectories of consumption, aggregate income, capital accumulation, and factor prices across time.

From our simulation results, we saw three key findings on how remittances influence the macroeconomy. First, as it progressively entered the economy as an additional source of income in the current period, it expanded both consumption when young and when old. This indicates that households became relatively financially better off with remittances allowing them to spread consumptions across their life period. Second, given preferences towards future consumption, it created savings in the current period that facilitated higher capital accumulation and aggregate income paths. Third, we also saw the mediated effect of proportional remittances on factor prices: it affected the wage path through household decision to supply labor; and it affected interest rate path through capital accumulation.

In addressing our third research objective, our key findings provide policy frameworks on managing remittances, given its economic implications. Our theoretical results continue to emphasize the need for OFWs and their respective dependents to be motivated and assisted in redirecting their remittances into productive use beyond current consumption, most often on non-durable goods. By seeing the power of remittances, as an additional source of income, in making a difference in the paths of our macroeconomic variables of interest, policymakers should already foresee its long run impacts by mobilizing initiatives to promote savings-investment schemes that will allow remittances to grow through entrepreneurial opportunities and reintegration programs for OFWs and their families, while anticipating its unintended consequences on other variables in the macroeconomic system, such as inflation and exchange rate. In this way, holistic interventions are introduced that will generate optimum leverage.

We recognize that we have barely scratched the surface. Hence, we recommend future studies to continue augmenting existing OLG models by exploring alternative and much better specifications of how remittances can enter the equation and benchmark its mathematical efficiency, intuitiveness, and consistency of results with existing models. Future studies can also introduce additional layers of complexities gleaned from reality (e.g., alternative specification of the utility and production function, *n*-economy model, additional life periods, heterogeneity of labor and/or capital, population dynamics to influence remittances, pure rate of time preferences, habit formation, taxation, subsidies, grants). This will allow theoretical models to much more closely approximate reality. Future studies can also explore alternative parameterization approaches on how different aspects of the economy can be represented. Such can be cross-examined with different studies either in the same locale or with other economies.

Hence, further results may generate complementary mental models that can enrich our cognizance of the impact of remittances on the macroeconomy towards better policy frameworks.

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