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Deflation Forces and Inequality

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Abstract

Proximity to short yield zero lower bounds has challenged the inflation targeting central banks of the advanced regions. Central to this development are three-decade declining trends in long yields and underlying real, equilibrium interest rates that have flattened yield curves, restricting “normalisation” and adding deflationary pressure by boosting demand for portfolio money. Inflationary forces, such as fiscal deficits, industrial protection and resurgent regional growth, have proved comparatively weak. In this paper global modelling is used to show that key deflationary forces in these regions include automation, the race to the bottom in capital taxation and immigration. Each is shown to redistribute income so as to expand the welfare gap between the low-skilled and capital owners by 2.5 to 3.5 per cent per year. The high saving rates of capital owners depress real equilibrium rates and their expanding portfolios demand monetary expansion. These forces ensure that the challenges of macro stabilisation and distributional policy making are both intertwined and urgent.

Keywords

Inflation, deflation, productivity, automation, income distribution, tax, transfers, general equilibrium analysis

JEL Classification

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Abstract

Proximity to short yield zero lower bounds has challenged the inflation targeting central banks of the advanced regions. Central to this development are three-decade declining trends in long yields and underlying real, equilibrium interest rates that have flattened yield curves, restricting "normalisation" and adding deflationary pressure by boosting demand for portfolio money. Inflationary forces, such as fiscal deficits, industrial protection and resurgent regional growth, have proved comparatively weak. In this paper global modelling is used to show that key deflationary forces in these regions include automation, the race to the bottom in capital taxation and immigration. Each is shown to redistribute income so as to expand the welfare gap between the low-skilled and capital owners by 2.5 to 3.5 per cent per year. The high saving rates of capital owners depress real equilibrium rates and their expanding portfolios demand monetary expansion. These forces ensure that the challenges of macro stabilisation and distributional policy making are both intertwined and urgent.

1. Introduction

Inflation rates in the advanced economies have been on a declining trend since the 1980s, diving more steeply in recent years.[1] Non-coincidentally, a similar declining pattern can be observed in nominal bond yields at all maturities.[2] The major central banks are now perceived to be less equipped to offset deflationary forces due to the proximity of the "zero lower bound" (ZLB) on yields in short maturity asset markets[3] and because of the associated declining trend in the "natural", or equilibrium, real rate of interest at the global level.[4] A consequence of these trends has been the transition by these central banks to unconventional monetary policy (UMP), the downsides of which stem from expected inflation that is below central bank targets, along with widening income and wealth disparities, the coincidence of firm "zombification" and low productivity growth, trade tensions due to associated exchange

[1] The recent decline in inflation is not simply explained by a fall in commodity prices. The decline in energy prices since 2014 has contributed as a deflationary force but it does not explain the fall in "core" inflation, which excludes energy and food, in both the US and Europe (Demary and Hüther 2015, Brainard 2017).

[2] The rate of inflation in Europe, Japan and North America has been seen as undesirably low (Rosengren 2014, Blitz and MacKenzie 2017, Conti et al. 2017, *The Economist* 2017c) and the duo of low inflation and low interest rates is seen as having unfortunate direct consequences (Fessenden 2017, *Financial Times* 2017) as well as limiting the capacity of central banks to respond to future negative shocks (Summers 2017).

[3] The ZLB arises because of the perception that no-one would choose to hold negative yielding bonds when zero-yielding cash is available as an alternative. Negative yields arise in practice mainly because the holding of cash is not costless (Rognlie 2016).

[4] Laubach and Williams (2003) define the equilibrium real rate of interest, which is monitored by the Federal Reserve Bank of San Francisco, and recent discussions of its declining trend include that by Rachel and Smith (2015), Williams (2015) and Holston et al. (2018).

rate movements and rising risk due to net leverage.[5] There is also a renewed debate over whether inflation targeting is the appropriate monetary policy for advanced regions, where unemployment (and output gaps more generally) have recently been stable at the low inflation levels.[6] These developments beg the question as to what are the deflationary forces that central banks are fighting against that have recently been so overwhelming.

A policy bias against deflation goes back at least to Keynes (1950: 10, and 2007: 16), whose concerns about its consequences, relative to those of inflation included unemployment due to nominal wage rigidity, the discouragement of borrowing for investment and the encouragement of money "hoarding", or increased holding of portfolio money at the expense of productive assets (Bagus 2015). The prospect of deflation is always associated with a lack of perceived capacity on the part of central banks to accommodate money demand, yet we assess that there are increasingly prominent deflationary forces in the global economy, the power of which has not been consistently assessed. We seek to compare their impacts by using a global model to decompose the money demand effects of each of these forces under conditions where inflation expectations are anchored at a zero target.

Inflationary (deflationary) forces include shifts toward optimism (pessimism) about future real disposable income and their consequences for consumption and investment expenditure and government deficits.[7] Deflationary forces also include the credibility of central bank inflation targeting, with short rates near the ZLB. Here we imagine that inflation expectations are anchored at central bank targets and classify deflationary forces as those that raise the demand for money relative to goods under these circumstances. While there are likely many sources of deflation in the advanced economies, we focus on three that have rising prominence in the economic policy literature, namely automation, the race to the bottom in capital income taxation and immigration.[8] Automation and immigration flows

[5] The literature on UMP and its consequences is now large. There is no doubt that UMP helped restore liquidity and capitalization to the banks and other financial institutions (Fawley and Neely 2013, Chodorow-Reich 2015). Yet its downsides have been linked to the negative feedback loop that sees low yields raise portfolio money holding, demanding monetary expansions via UMP that have further reduced yields. See Burns et al. (2014), BIS (2017), Gugliano (2017), Watling (2017) and Williams (2015) for more discussion.

[6] Concern is expressed to make monetary policy more pro-active in addressing output gaps by such authors as Stiglitz (2011) and alternative proposals are offered by Frankel (2012 a and b). These are reviewed by Gillitzer and Simon (2015), who favor a lengthened CPI target horizon. A recent reconsideration is available at Brookings (2018).

[7] Increased protection across trading partners is also collectively inflationary. This is a force that may become stronger in future, possibly even offsetting those considered in this paper.

[8] One deflationary force that we neglect is the modern prominence of value chains and the rising significance in the advanced economies of external value added. These have been deflationary because transaction volumes include intermediates, the trade in which also requires liquidity, and since these networks constrain costs (Auer

suppress real wage growth and all three forces have the common feature that they deliver greater returns to high-saving capital owners, raise collective saving relative to investment demand and so reduce the Wicksellian (1898) real equilibrium interest rate in the comparatively integrated global financial capital market.[9]

To analyse these effects we employ a special purpose macro model of the global economy on six regions that parameterizes the global integration of financial and product markets via asset and product differentiation and that incorporates expectations over consumer and GDP price indices. Money demand in each region is driven by product transactions, financial transactions and portfolio rebalancing in response to real long yields, which we regard as representing the opportunity cost of money holding.[10] In response to the three deflation forces, departures from a zero growth, zero inflation growth path, with inflation expectations anchored at zero, are then recorded.

Our results suggest that, by redistributing income to high-saving households globally, sufficient to grow the gap between the real disposable income of capital owning relative to working households by 2.5 to 3.5 per cent per year, and thereby raising global saving, the three prospective forces reduce real long interest rate *levels* by around two per cent per year.[11] The monetary expansions then required to keep pace with these forces alone raise money demand by between 2.2 and 3.2 per cent per year. The effectiveness of macroeconomic policy in stabilising performance around growth trends in the advanced economies is thus shown to depend on how governments address the distributional effects of these forces.

We briefly note the stylised facts in Section 2. The modelling undertaken is summarised in Section 3 with fine details relegated to an appendix. The results obtained are discussed in Section 4 while Section 5 concludes.

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et al. 2017). We neglect this force here because it appears to have had most effect in the decade prior to the GFC but its effects have abated since.

[9] Immigration is not among the determinants of rate decline considered by Holston et al. (2018) but there is a growing literature on its macroeconomic impacts that includes Kirby and Riley (2006), Nickell (2007), Goodhart and Pradhan (2017) and Harris et al. (2018). Recent popular interest is indicated by *The Guardian* (2018).

[10] Financial transactions have significant effects on demand for liquidity, following Baumol (1952) and Tobin (1956) and capital owners are the largest holders of precautionary/portfolio money (Ragot 2014, Mena and Tirelli 2017).

[11] With real long maturity yields currently of the order

2. The Stylised Facts

Key trends interlink macroeconomic with distributional performance in the advanced economies. We take these in turn.

2.1 Macro and Financial Performance:

With the passing of real anchors in the early 1970s a period of financial volatility ensued with monetary policy targets in the advanced economies transitioning from gold and exchange rates through money aggregates to inflation rates.[12] Throughout this period most central bank mandates also attached weight to measures of real output and unemployment but their focus has been on a target range for inflation.[13] As indicated in Figure 1, with the transition to inflation targeting, consumer price index (CPI) inflation rates in these advanced economies stabilised in the 1990s, though they have trended even lower very recently. Indeed, the corresponding rates of producer price inflation, while historically more volatile, show a marked dip into deflation since 2014. With this has come resurgent employment growth but with the notable absence of wage inflation.

At the same time the declining trend in government bond yields, both of short and long maturity, has been dramatic and continuous, as shown in Figure 2.[14] This is notwithstanding the very substantial fiscal deficits, which are larger relative to GDP than the advanced economies' GDP growth rates. The associated rising trend in gross sovereign debt shown in Figure 3 might otherwise be expected to drive up borrowing costs. The most recent estimates of the underlying real equilibrium interest rate by Holston et al. (2018), which adjust for fiscal balance and full employment at the country level, are shown in Figure 4. These have declined correspondingly and closely with inflation adjusted long nominal yields.

The coincidence of falling government borrowing rates and continuing high fiscal deficits suggests a surge in the global demand for bonds issued by advanced country governments, and particularly, for those issued in the US. Prior to the GFC the culprits for this were the high-saving Asian economies (Arora et al. 2015) but, since then, the demand has been

[12] In the developing world monetary policies have been dominantly focused on exchange rates against such currencies as the USD, though the IMF has been advising developing countries to transition to inflation targeting since the 1990s (Masson 1997) and increasing numbers are now adopting inflation targeting (Amato and Gerlach 2002). As in Australia, this allows uncontroversial exchange rate movements against the USD.
[13] This is formalized in the widely discussed Taylor Rule (Taylor 1993), though such formality is shunned by central banks in favour of discretion.
[14] Note the brief inversion of Australia's yield curve in the lead-up to the GFC, due to the inflationary effects of the boom in Chinese commodity imports and the Reserve Bank of Australia's preference to see the exchange rate appreciate rather than to have it cause domestic inflation.

spurred by central bank buying of long-maturity assets following transitions to UMP in Japan then the US and the UK, and finally, in continental Europe. This triggered wider private interest in long maturity government (and, more recently in European private) debt, leading to what has been described as a "bond bubble" (Krishnamurthy and Vissing-Jorgensen 2012, Maley 2016, Price 2016).

2.2 Income Distribution

That inequality has risen across the OECD countries since the 1960s is clear from Figure 5. We note also that, at least for some OECD countries, real net national product per capita has been stagnant since the 2005. This is clear from Figure 6 and, combined with the evidence from the previous figure that inequality has increased it suggests that these countries' poorer households have suffered declining welfare in this period. Further light is shed by the associated trends in total factor productivity (TFP), shown in Figure 7. These, also, show a transition around 2005 to stagnant productivity throughout the OECD. Changes in the "choice of technique" that have disadvantaged low-skill workers have also been occurring for decades. These changes are indicated by declining low-skill labour shares of total value added, shown in Figure 8. This declining trend is also generic across the OECD, though it is shown here for the US. It is the subject of a substantial literature of its own, with conclusions that divide responsibility between automation on the one hand and outsourcing and trade on the other.[15]

To add to this there is the succession of declines in advanced region tax rates on capital income (Broadman 2017). These exacerbate the inequality effects mentioned above but, further, they (and their prior anticipation) draw in investment from the rest of the world to lower-taxing economies, which temporarily appreciate exchange rates causing a complementary deflation force. A further change that has influenced performance and inequality in the advanced economies over these decades is immigration from poorer regions. The contributions of migrants to population changes are shown in Figure 9 to have been substantial, particularly in Australia. Since immigration advantages capital owners most and low-skill workers least, it has clearly contributed to the rises in inequality observed in Figure 5. The contribution this makes to greater saving and lower opportunity costs of holding money is then complemented by the acceleration in labour supply growth that suppresses real

[15] See Onaran et al. (2011), Gozgor and Ranjan (2017), Tyers and Zhou (2017), and Zhou and Tyers (2017).

wage rates and impairs worker conditions, also contributing to deflation, via reduced production costs.[16]

3. Modelling Deflationary and Distributional Forces

To obtain an assessment of the key deflationary forces, we adapt a model of the global macro-economy, including in it multiple households and trade in intermediate inputs, so as to capture the deflationary forces that operate, at least in part, through changes in inequality.[17] We use the model to simulate the effects of the three main deflationary forces that we believe are likely to be sustained or to strengthen in the future.

3.1 The Model

A multi-region general equilibrium structure is used that centres on the global financial capital market. It is assumed that the financial products of each region are differentiated and that portfolio managers assign new net saving across regions so as to maximise expected portfolio returns given this differentiation. Although there is a tendency for financial flows to move the global economy toward uncovered interest parity, in the length of run considered asset differentiation leaves this process incomplete. At the same time, expected rates of return depart from regional bond yields, the latter reflecting short run equilibria in regional financial markets, as between savers, indebted governments and investors.

Production technology is structured so as to enable factor bias shocks to occur without changing total factor productivity, and vice versa, so as to capture the factor bias associated with automation and outsourcing. In each of six regions, three households are defined based on factor income (low-skilled, skilled and capital-owning) and these have separate income transfers from governments and separate consumption behaviour.

Global financial markets

Each region's financial market is represented as the market for domestic long maturity assets. Purchasers of these assets are assumed to respond to changes in an expected rate of return on installed domestic capital, which is net of depreciation and capital tax and adjusted for sovereign risk. This rate of return is inversely proportional to the stock of utilized regional

[16] See Kirby and Riley (2006), Bentolila (2007), Blanchflower (2007), Nickell (2007) and Nickell and Saleheen (2015).
[17] The model is a blend of the macro models used by Tyers (2015a and 2015b, 2016) and the distributional models used by Tyers and Zhou (2017) and Zhou and Tyers (2017).

capital and its expected future value is first adjusted by a sovereign risk factor and then embedded in an interest parity condition that provides for incomplete arbitrage. Finally, a sovereign risk factor is added to reflect that deteriorating fiscal balances cause investment to be less attractive. The domestic demand for investment financing then depends on the ratio of the expected real rate of return on installed capital, which is defined as after capital income tax, and the real long bond yield that clears the domestic financial market, r.[18] Since the numerator indicates the market value of domestic assets and the denominator the cost of financing their replacement, this is in the tradition of Tobin's Q.

This investment demand is then matched in each region by a supply of saving that incorporates contributions from all regional households and governments. Here the modelling incorporates explicit portfolios of assets from all regions. Data on regional saving and investment is first combined with that on international financial flows to construct an initial matrix to allocate total domestic saving in each region to investment across all the regions. From this is derived a corresponding matrix of initial shares of region i's net (private and government) saving that are allocated to the local savings supply that finances investment in region j, i_{ij}^{S0}. When the model is shocked, the new shares are calculated so as to favour investment in regions, j, whose real yields are boosted by the shock. Since these are portfolio investments, the real rate of return available in each region is assumed to be the domestic market clearing yield, r.

Region i's portfolio manager allocates the proportion i_{ij}^{S} of its annual (private plus government) saving to new investments in regions j, such that $\sum_j i_{ij}^{S} = 1$.[19] Because the newly issued equity is differentiated across regions based on un-modelled and unobserved region-specific properties, their services are combined via a constant elasticity of substitution (CES) function specific to each regional portfolio manager. Thus, region i's household portfolio management problem is to choose the shares, i_{ij}^{S}, of its private saving net of any government deficit, $S_i^D = S_i^P + T^D + T^I - G$, which are to be allocated to the assets of region j so as to maximise a CES composite representing the value of the services yielded by these assets:

[18] Since firms do not incur tax when issuing stock or bonds, no taxation is applied in the denominator.

[19] The manager does not re-optimise over total holdings every year. This is because the model is deterministic and risk is incorporated only via exogenous premia. The motivations for continuous short run rebalancing, other than the arrival of new saving, are therefore not represented.

$$(1) \qquad \max_{i_{ij}^S} U_i^F = S_i^D \left[\sum_j \alpha_{ij} (i_{ij}^S)^{-\rho_i} \right]^{-\frac{1}{\rho_i}} \text{ such that } \sum_j i_{ij}^S = 1.$$

Here α_{ij} is a parameter that indicates the benefit to flow from region *i*'s investment in region *j*. The CES parameter, ρ_i, reflects the preparedness of region *i*'s household to substitute between the assets it holds. To induce rebalancing in response to changes in rates of return the α_{ij}s are made dependent on ratios of after-tax yields in destination regions, *j*, and the home region, *i*, via:[20]

$$(2) \qquad \alpha_{ij} = \beta_{ij} \left[\frac{r_j \left(1 - t_j^K\right)}{r_i \left(1 - t_i^K\right)} \right]^{\lambda_i} \quad \forall i, j, \quad \lambda_i > 0 \quad \forall i \ .$$

Here, t_i^K is the rate of capital income tax rate in region *i*. This relationship indicates the responsiveness of portfolio preferences to yields, via the (return chasing) elasticity λ_i. Region *i*'s elasticity of substitution between the bonds of different regions is $\sigma_i^I = \lambda_i / (1 + \rho_i) > 0$, which has two elements. The return-chasing behaviour of region *i*'s household (λ_i) and the imperfect substitutability of regional bonds, and therefore the sluggishness of portfolio rebalancing (ρ_i). For the purposes of this analysis the values of σ_i^I are seen as indicating the extent of each region's integration with global financial markets. The optimal share of the net domestic saving of region *i* that is allocated to assets in region *j* then follows from the solution, which is readily calibrated from available data, as discussed in the appendix.

Next we characterize the regional money market equilibrium. Within each region the demand for money is driven by a "cash in advance" constraint. For any one household, home money is held in a portfolio with long maturity bonds, which are claims over physical capital, combined with home and foreign long maturity government debt, and so the opportunity cost of holding money is the long maturity yield. The cash-in-advance constraint is assumed to generate transactions demand for home money across all components of gross (including intermediate) output. This effect is here augmented by the real purchasing power of financial wealth, to account for the observed dominance of financial transactions over money

[20] Note that region *i*'s market bond yield, r_i, is determined concurrently and indicates the replacement cost of capital in region *i* and therefore the opportunity cost for region *i*'s household of investment in region *j*.

demand.[21] The opportunity cost of holding home money is set at the nominal after-tax yield on home long term bonds.[22] Real money balances are measured in terms of purchasing power over home products at the GDP price, P^Y.

$$(3) \qquad m_i^D = a_i^{MD}\left(y_i\right)^{\varepsilon_i^{MY}}\left(w_i^F\right)^{\varepsilon_i^{MW}}\left(\frac{r_i\left(1+\pi_i^e\right)}{\tau_i^K}\right)^{-\varepsilon_i^{MR}} = \frac{M_i^S}{P_i^Y} = \frac{\mu_i M_i^B}{P_i^Y}.$$

For region i, y_i is real, regional gross output, as distinct from real GDP since intermediates are transacted as well as goods and services entering final demand. Real financial wealth is w_i^F, τ_i^K is the power of the capital income tax rate in region i and π_i^e is the expected inflation rate of the consumer price level, P^C, defined as a CES aggregate of home and imported consumer prices. Real financial wealth or assets, w^F, is represented as the present value of an infinite stream of real dividends that are equal to after-tax returns on the capital stock, at the expected real rate of return on installed capital, r^{ce}, discounted at the current real financing rate, r. A price adjustment is also made for relative inflation or deflation of capital goods prices, which raise or lower the purchasing power of financial wealth over home products.

$$(4) \qquad W_i^F = \frac{r_i^{ce}\left(1-t_i^K\right)\left(P_i^K/P_i^Y\right)K}{r_i}.$$

The last three decades have exhibited advanced region asset price inflation that has exceeded that in goods, for the US by at least six percentage points per year on average,[23] suggesting a rising path of this ratio. This comparative growth in financial wealth is due to the many determinants of wealth inequality, including the forces discussed in this paper.

On the supply side of the money market, the proportion of expansions that occur via the purchase of long maturity assets (UMP) is parameterised. Conventional expansions directly affect the money supply while UMP expansions affect both it and the long end of the yield curve. UMP expansions raise home long maturity asset prices and lower long yields, causing

[21] The inclusion of financial wealth in the money demand equation follows Ragot (2014) and Mena and Tirelli (2017), who incorporate Baumol (1952) – Tobin (1956) behaviour.

[22] Thus, it is assumed here that the opportunity cost of holding money is measured by the long bond yield, which is the dominant determinant of non-money portfolio yields. Short rates, at least as they have a role in conventional monetary policy, are here embedded in the determination of the monetary base. While housing investment can be sensitive to short rates in economies where most mortgage contracts have variable rates, the assumption that investment financing depends on the long maturity market is a simplifying abstraction in this global analysis.

[23] This is readily concluded from a comparison of the path of a broad index of stock prices, such as the Wilshire Capital Price Index, and the US CPI, since 1990.

imperfect spill-overs due to global arbitrage that is only partially constrained by asset differentiation.[24]

Regional financial market clearance requires that the home financial market in each region clears separately and this implies global financial market clearance. For region *i*, the nominal value of domestic investment, I_i^D, from (5), represents the sum total of all domestic long bond issues. This is then equated with demand for those bonds from home and foreign (net private and government) savings, along with demands for home long bonds that arise from the "quantitative easing" components of monetary expansions by both home and foreign central banks.

Financial balance then requires that total investment spending in region *i*, in *i*'s local currency, is equated with the total supply of financing directed from all represented regions:

$$(5) \qquad I_i^D = \sum_j \left(\left[i_{ji}^S S_j^D + \theta_{ji}^{QE} s_j^{QE} \Delta M_j^B \right] \frac{E_j}{E_i} \right), \quad \forall i \ ,$$

where E_i is the nominal exchange rate of region *i* relative to the US$, which is the numeraire in the model ($E_{US}=1$). The "quantitative easing" component of the current period's expansion of the monetary base by region *j*'s central bank, s_j^{QE}, and the share of this expansion that takes the form of acquisitions of region *i*'s long bonds, θ_{ji}^{QE}, both determine central bank demand. These flows are originally in foreign currency and are therefore converted at the appropriate cross rates. The regional real bond yields (interest rates, r_j) emerge from this equality. Their convergence across regions is larger the larger are the elasticities of asset substitution, σ_j^I.

The balance of payments condition requires that the sum of net inflows of payments on the current account and net inflows on the capital and financial accounts, measured in a single (home) currency is zero:

$$(6) \qquad X_i - M_i + \sum_{j \neq i} \left(\left[i_{ji}^S S_j^D + \theta_{ji}^{QE} s_j^{QE} \Delta M_j^B \right] \frac{E_j}{E_i} \right) - \sum_{j \neq i} \left(i_{ij}^S S_i^D + \theta_{ij}^{QE} s_i^{QE} \Delta M_i^B \right) = 0, \quad \forall i \neq "US"$$

[24] By contrast, conventional monetary policy involves trade in short term instruments which has no direct impact on the market for long term bonds. Short rates are therefore not modelled explicitly, rather the monetary base in each region is determined as endogenous to the target of monetary policy and an exogenous parameter determines the share of any change in the monetary base that takes the form of long asset balance sheet expansion.

The first terms are values of exports and imports (formulated in the appendix) while the second two terms are financial inflows and outflows. The first parenthesised term represents acquisitions of region *i*'s home-issued long bonds by foreign savers and by foreign central banks, the latter associated, as above, with the "quantitative easing" component of the current period's expansions of the monetary bases across regions. These net saving and central bank flows are originally in foreign currency and so are converted at the appropriate cross rates. The second parenthesised term represents acquisitions of foreign-issued long bonds by region *i*'s home savers and its own central bank. A balance of payments in the US is implied by balance in all the other regions. These equations determine the nominal exchange rates. Since these are defined relative to the US$, that for the US is always unity $\left(E_{US}=1\right)$.

The supply side

Six regions are identified: the US, the EU, Japan, China, Australia and the Rest of the World.[25] Each region supplies a single product that is also differentiated from the products of the other regions and this product is both consumed directly and used as an intermediate input at home and abroad. There are three primary factors with low-skill labour a partially unemployed variable factor while the stocks of physical capital and skill are exogenous and fully employed. Although each region supplies a unique differentiated product, production is assumed to draw on a combination of intermediate inputs comprising the home product and imports of products supplied abroad. This allows the capture of differences between the international effects of a policy change in one large country that are due to the dependence of smaller countries on the supply of inputs on the one hand or final products on the other.

The central production technology is expressed in Cobb-Douglas form. Output and factor inputs are included as relative to initial levels so that shocks to productivity or factor shares do not imply changes in initial output volumes, thus facilitating the subsequent decomposition of technology shocks as between productivity and factor or input bias. In region i gross output volume, y_i, is a Cobb-Douglas composite of real value added, v_i, and of intermediates, q_i.

$$(7)\qquad \frac{y_i}{y_i^0}=\left(\frac{A_i^Y}{A_i^{Y0}}\right)\left(\frac{v_i}{v_i^0}\right)^{\beta_i^V}\left(\frac{q_i}{q_i^0}\right)^{\left(1-\beta_i^V\right)},\forall i, i\in\left(regions\right),$$

[25] The EU is modeled as the full 28 and it is assumed that this collective has a single central bank.

where A^Y is total (factor and input) productivity. Value added, in turn, has Cobb-Douglas dependence on domestic primary factors, raw labour, L, skill, S and physical capital, K.

$$(8) \qquad \frac{v_i}{v_i^0} = \left(\frac{A_i^V}{A_i^{V0}}\right)\left(\frac{L_i}{L_i^0}\right)^{\beta_i^L}\left(\frac{S_i}{S_i^0}\right)^{\beta_i^S}\left(\frac{K_i}{K_i^0}\right)^{\beta_i^K}, \sum_f \beta_i^f = 1, \forall i, f \in (\textit{factors}).$$

To allow for inter-regional substitution in intermediate demand across regional sources, domestically employed intermediate inputs, q, are a CES composite of products acquired from all regions:

$$(9) \qquad q_i = \left(\sum_j \alpha_{ij}^Q q_{ij}^{-\theta_i^Q}\right)^{-\frac{1}{\theta_i^Q}}, \forall i,$$

where q_{ij} is the quantity of region j's product that is absorbed by production in region i.

The composite prices of value added and intermediate inputs from (7) are related via:

$$(10) \qquad \frac{P_i^V}{P_i^P} = \beta_i^V \frac{y_i}{v_i}, \quad \frac{P_i^Q}{P_i^P} = \left(1-\beta_i^V\right)\frac{y_i}{q_i}, \forall i \quad .$$

Here P_i^P is the producer price level – the factory gate price of region i's product. The real production wages of unskilled and skilled workers and the capital rental rate depend conventionally on the corresponding marginal products.

The gross volume of output, y, is distinguished from real GDP, which is that portion of output that meets final demand, excluding intermediate use, and which equates to real value added, v in (7). The complete set of demands facing country i's industries, which must sum to equate with (7), takes the form:

$$(11) \qquad y_i = \frac{I_i + G_i}{P_i^P} + \sum_j c_{ji} + \sum_j q_{ji} \ ,$$

which is a real version of the standard expenditure identity (on the homogeneous domestic output of region i) with intermediate demand included. I and G are nominal gross investment and nominal government spending net of transfers, c_{ji} is the volume of final consumption of region i's product in region j, and q_{ji} is the volume of region i's product that is absorbed as intermediate inputs by production in region j. Net trade is embodied in the second term and real GDP omits the final term. Equating this with (7) determines producer price levels, P^P, in

each region. Producer cost minimisation at these prices then determines all the unit factor rewards.

Household disposable income

Disposable income, for each household, takes the form:

$$(12)\qquad \begin{aligned} Y_{hi}^{D} = {} & s_{hi}^{L}\left[\left(1-t_i^{L}\right)W_i L_i + \alpha_i W_i^{o}\left(F_i - L_i\right)\right] + s_{hi}^{S}\left(1-t_i^{S}\right)W_i^{S} S_i^{K} \\ & + s_{hi}^{K}\left(1-t_i^{K}\right)K_i\left(P_i^{P}\, MP_i^{K} - P_i^{K}\,\delta_i\right) + T_{hi}^{R}\,, \quad \forall h \end{aligned},$$

where $T_h^R = t_h^R N_h Y$ is a direct transfer to the household from government revenue, with t_h^R the transfer rate to household h per unit of group population, N_h, and per unit of nominal GDP.[26] For each household, h, in region i, consumption expenditure, C_{hi}, is a nominal sum but real consumption behaviour is motivated by current and expected future real, per capita, disposable incomes and the real interest rate. Real consumption, (lower case) c_{hi}, depends negatively on the after-tax real return on savings (the home bond yield, r) and positively on both current and expected future real disposable income per capita for that household:

$$(13)\qquad c_{hi} = \frac{C_{hi}}{P_i^C} = N_i^h A_{hi}^C \left(\frac{r_i}{\tau_i^h}\right)^{-\varepsilon_{hi}^{CR}} \left(\frac{Y_{hi}^D}{N_i^h P_i^C}\right)^{\varepsilon_{hi}^{CY}} \left(\frac{Y_{hi}^{De}}{N_i^h P_i^C\left[1+\pi_{hi}^{Ce}\right]}\right)^{\varepsilon_{hi}^{CY}},$$

where the tax rate on interest income, τ^h, is household specific, set as the tax rate on the households dominant source of direct factor income. The expected inflation rate of the consumer price level is π^{Ce}. The elasticities in this expression vary by household, ensuring different consumption responses.

Consumption driven trade and composite pricing

To capture the home household's substitution between home and foreign products, real aggregate consumption in region i is a CES composite of region i's consumption of products from all regions:

$$(14)\qquad c_i = \left(\sum_j \alpha_{ij}^C c_{ij}^{-\theta_i^C}\right)^{-\frac{1}{\theta_i^C}}$$

[26] The expression (12) is more complex if the labour force participation rates of low skill workers, λ_{Lh}, are unequal across households and, similarly, if participation rates of skilled workers, λ_{Sh}, are unequal across households. The simpler expression is offered here since this is not the case in this analysis. The participation rates within skill groups and across households are kept equal in the experiments conducted, although the rates differ *between* skill groups and may be differently shocked.

The home household then chooses its mix of consumed products to minimise consumption expenditure in a way that accounts for home consumption and trade taxes, foreign export taxes, differing foreign product prices and exchange rates:

$$(15) \qquad C_i = P_i^C c_i = P_i^P \tau_i^C c_{ii} + \sum_{j \neq i} \tau_i^C \tau_i^M \tau_j^X c_{ij} P_j^P \frac{E_j}{E_i} \ ,$$

where τ_i^C is the power of region *i*'s consumption tax. Optimum consumption is consistent with an elasticity of substitution between home and foreign products of $1/\left(1+\theta_i^C\right)$. Given these consumption volumes, the composite price of all consumption, or the consumer price level, emerges as:

$$(16) \qquad P_i^C = \tau_i^C \left[\left(\alpha_{ii}^C\right)^{\sigma_i^C} \left(P_i^P\right)^{1-\sigma_i^C} + \tau_i^M \sum_{j \neq i} \left(\alpha_{ij}^C\right)^{\sigma_i^C} \left\{ \frac{P_j^P E_j}{E_i} \right\}^{1-\sigma_i^C} \right]^{\frac{1}{1-\sigma_i^C}} .$$

The above are critical equations in this model of the global macro-economy. The complete model is documented in the appendix which is available upon request from authors.

4 Simulating Deflationary Forces

Here we implement stylised shocks , first to choices of technique that disadvantage low-skill labour, for which our shorthand is automation, then to tax rates on capital income, which decline collectively, and, finally, to migration flows from the "Rest of World" region to Europe, the US and Australia. The automation shocks continue the decline in the low-skill share that is apparent from Figure 8. The model structure we use (equations 7 and 8 in the previous section) allows these shocks to be introduced while holding TFP constant, so that they represent pure factor bias.[27] The capital taxation shock is a uniform reduction in the power of capital income tax rates by five per cent and the migration shock is a continuation of the recent migration contributions to population growth illustrated in Figure 9. Age distribution effects are ignored so that corresponding shocks are applied to labour forces and the same rates are applied to the low-skill and skilled labour forces. The proportional shocks are largest by far for Australia but significant in Europe given its comparatively static population.

[27] This follows the more detailed national level analysis by Tyers and Zhou (2017).

The three sets of shocks are imposed over a decade relative to a zero growth steady state, under the following closure assumptions. First, monetary policy in the advanced economies targets inflation at zero and inflation expectations are anchored at this level. In the other regions exchange rates against the US$ are targeted and inflation expectations are model consistent. Second, labour markets are assumed to maintain their current level of clearance, so that there are no changes in regional unemployment rates. Third, there is no change in nominal government spending in each region, nor in government fiscal positions. Adjustments for fiscal balance take place via changes in rates of tax on consumption expenditure. We do this because, as conventional tax bases (incomes to skill and capital) become more inaccessible due to the international mobility of these factors, the rising need to finance transfers must be met from indirect taxation, and consumption expenditure is the elephant in that room. Importantly, however, these simulations offer no new government intervention (system of taxes and transfers) to address the increases in inequality that emerge. The wage rates of low-skill workers fall, as do the incomes of the households that depend on them. Fourth, scope is allowed for changes in investment flows to cause international redistributions of the global capital stock. The results are then annualized and presented in the form of growth rates. Because our line of reasoning goes primarily from income redistribution to saving, then to real equilibrium interest rates and thence to money demand, we begin with the distributional effects of these shocks.

4.1 Distributional Effects:

To see the extent of the redistributions that emerge from the prospective deflationary shocks, we observe the impacts of each on the real purchasing power of disposable income per capita for households depending for their incomes on low-skill labour, skill and capital. The results are shown in Table 1. In all cases the affected regions face redistributions of income toward capital owning households, even where the shocks also benefit working households. Migration shocks neither apply to Japan, nor to China, and so the relative performances of their working and capital-owning households are unaltered. The redistributions are, understandably, largest in the case of biased changes in choice of technique, which we summarise as automation.

The pattern in response to company tax reductions is that first movers gain from capital injections and these offer benefits to working households. Even when, as simulated, the tax reductions spread to all regions, worker households in the US, Europe and Australia appear to be minor net beneficiaries. These benefits, however, are swamped by those accruing to

capital owners in all regions. This pattern is sustained when the distributional effects of all three shocks are added together. Even though some low-skill, working household groups across the regions appear to derive small benefits, overall the net gains to these households are negative or insignificant compared to those accruing to capital owners, which, from these deflationary forces alone, enjoy real per capita disposable income growth of between 1.6 (Japan) and 2.5 (Europe) per cent per year. Indeed, the gap between benefits to the capital owning households and the low-skill households expands due to these forces alone at an annual rate of between 2.5 and 3.5 per cent per year.

4.2 Equilibrium Yield Effects

The simulated changes in long yields are detailed in Table 2. Two forces are in action. First, the income concentrating effects of the shocks raise global saving rates relative to regional investment, reducing real long yields. Second, UMP is assumed to persist in Europe and Japan and the increases in money demand associated with these shocks, to be detailed below, require further central bank asset expansions. This additional bond buying by their central banks raises long bond prices and further reduces their yields. Incomplete global bond market arbitrage sees these effects spread across global financial markets, with the result that the regional long rate changes are similar across regions.

4.3 Money Demand Effects

All three shocks require monetary expansions to sustain inflation targets, though magnitudes vary by shock and across regions. As modelled, via expression (3), money demand has three determinants. First, there is transaction financing for the economy's gross product, which includes transacted intermediate inputs. [28] Second, we include financial transactions demand that rises with financial wealth, and hence increases with growth and inequality, and third, there are portfolio adjustments in response to the declines in long yields, which encourage greater holdings of portfolio money. Under our no-growth equilibrium with zero inflation targets and anchored inflation expectations, the sizes of the simulated changes in money demand are measures of the power of each deflationary force. These changes are indicated in Table 3.

[28] The redistribution to high-saving capital-owning households suggests the possibility of a decline in consumption volume and a corresponding decline in product transaction demand. This does not occur in the simulations. All products, including intermediates, are transacted, and gross output rises in response to these shocks in all advanced economies. Real consumption also increases overall, though that by low-skill households contracts in regions not receiving immigrants.

The monetary implications of the automation shocks appear to be stronger in all regions than the other two deflationary shocks. Automation suppresses real wage costs while at the same time boosting the incomes of capital-owning households, whose saving contributes to the long yield declines discussed above that, in turn, reduce the opportunity cost of holding portfolio money. The gains to capital owners see substantial asset portfolio expansion, which contributes more than the other two determinants to rises in money demand. Portfolio rebalancing in response to reduced long yield is the next largest contributor. The traditional perspective that money demand relies on goods transactions demand offers the minor contribution here. Notably, however, this contribution is largest in the case of the migration shocks, in the migrant receiving regions. It is in these regions that migrants boost both real output and the volume of goods transactions. Indeed, in the case of Australia, where immigration is the major contributor to population growth (Figure 9), the growth in money demand due to immigration is largest and the contribution of goods transactions demand is largest across the regions.

Overall, as simulated, the three prospective deflationary forces require annual monetary expansions in the range of 2.2 to 3.2 per cent. This places demands on monetary authorities, which are constrained by the ZLB at the short end and downward pressure on rates at the long end. For the US, this compares with a growth rate of M3 since 2013 of about five per cent per year, which has arisen via rising bank lending and a rise in the money multiplier, without any significant change in the monetary base.[29] Plans for the Fed to contract its asset portfolio, however, will be contractionary and so meeting demands from the three deflationary forces will depend on further liquidity creation by the private sector. In the case of Australia, the growth of M3 in this period has been at about six per cent per year, with corresponding growth in the monetary base and no increase in its much larger money multiplier.[30] If the three deflationary forces persist, there is a chance that Australia's continued use of conventional monetary policy may be threatened by the ZLB.

[29] US values for M3 and the monetary base are from FRED, St Louis Fed. They imply a money multiplier that has risen from 2.9 to 3.6 since 2013. This multiplier is low because the monetary base reflects the substantial assets accumulated by the US Fed during its UMP.
[30] Australian values for M3 and the monetary base are from the RBA. They imply a multiplier that has been stable since 2013 at about 19.

5. Conclusion

Using a general equilibrium model of the global economy that incorporates representative behavioural parameters, we analyse the effects of three deflationary forces that act primarily by redistributing income in favour of capital owners, thereby raising the rate of growth of global saving and reducing real yields on long maturity assets. This, in turn, reduces the opportunity cost of portfolio money holding and stimulates the growth of money demand. Under closures that have the advanced regions' central banks target zero inflation, and private inflation expectations anchored at this level, these forces have the effect of requiring increased growth in money supplies in order to avoid deflation. The proximity of short rates to the ZLB and the contribution these forces make to the flatness of the yield curve limit central banks' capacity to accelerate money supply growth, risking future deflationary episodes.

Because the forces considered are most notably redistributive, their effects on the capacity of central banks to provide macroeconomic stabilisation around growth trends in the advanced economies depend on how governments address the distributional effects. Without further intervention our simulations imply that the gap between benefits to the capital owning and low-skill households will expand due to these forces alone at an annual rate of around three per cent per year. With intervention, not only will inequality be constrained but so also will the deflationary impacts of these shocks.

Competing types of intervention include the universal basic income, the popularity of which is rising in Europe, and the earned income tax credit, which originates from the US. While the earned income tax credit appears to offer better outcomes (Tyers and Zhou 2017), mainly because it maintains higher levels of employment and output, both will require more "fiscal space" than is currently available in the advanced economies. This, in turn, will require transitions to more indirect taxation regimes that will, at least temporarily, be inflationary. The race to the bottom under way on capital income taxation will advantage low-skill households in the US and other first moving regions but capital-owning households disproportionately. Eventually, however, it will reduce fiscal space. A redistribution of the taxation burden toward indirect taxes is an essential development on the horizon, particularly in North America and Japan but also in Australia. With fiscal interventions such as an indirect tax financed earned income tax credit system, the effects on long maturity yields and money demand would be smaller. The inescapable conclusion is that the tasks of macro

stabilisation on the one hand and maintaining acceptable distribution on the other are now deeply intertwined.

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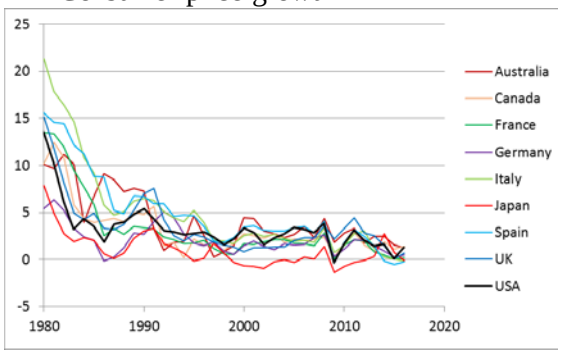
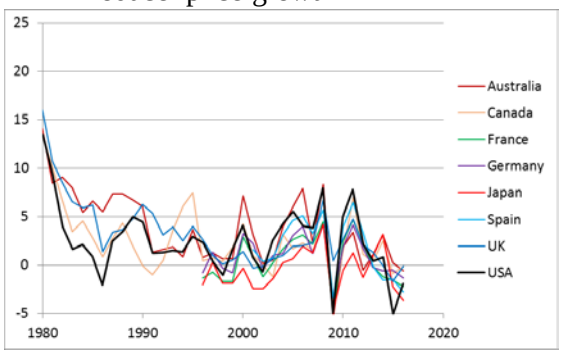
Figure 1: Annual Inflation Rates

Consumer price growth



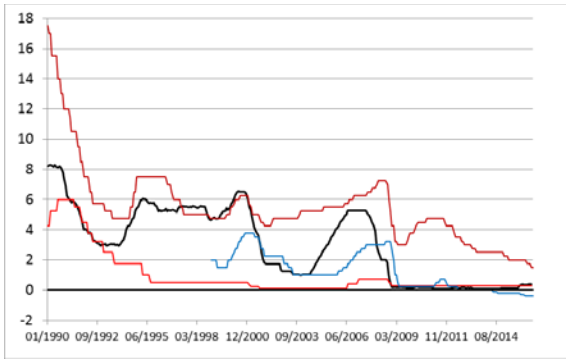
Producer price growth



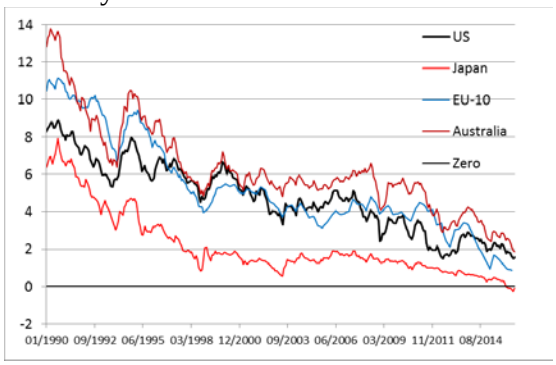
Source: Federal Reserve Bank of St Louis Database (FRED), IMF *World Economic Outlook*, October 2017.

Figure 2: Government Bond Yields

3 months



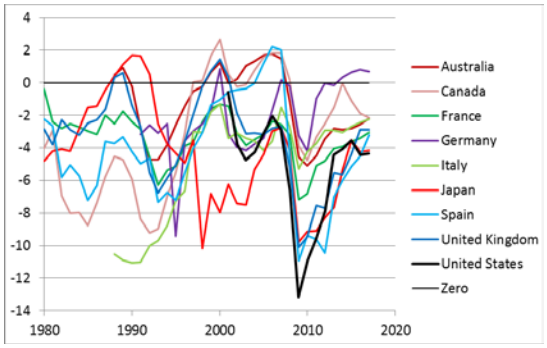
10 years



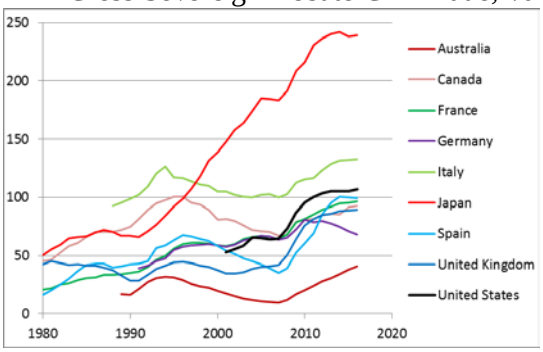
Sources: Sources: US rate from FRB of St Louis (FRED), European rate from European Central Bank (sdw.ecb.europa.eu), Australian rate from the RBA (rba.gov.au/statistics), Japanese rate from ECB (sdw.ecb.europa.eu).

Figure 3: Fiscal Deficits and Sovereign Debt

Deficit to GDP Ratio

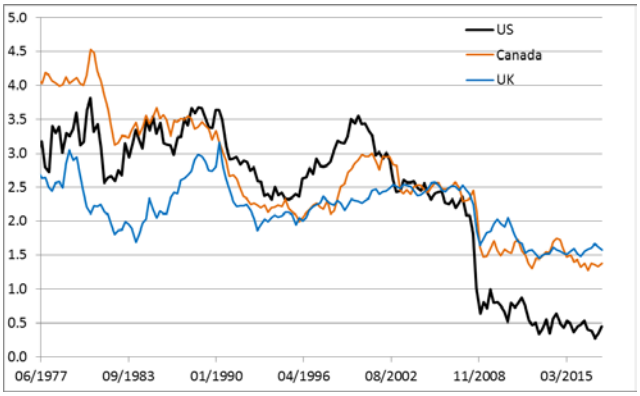


Gross Sovereign Debt to GDP Ratio, %



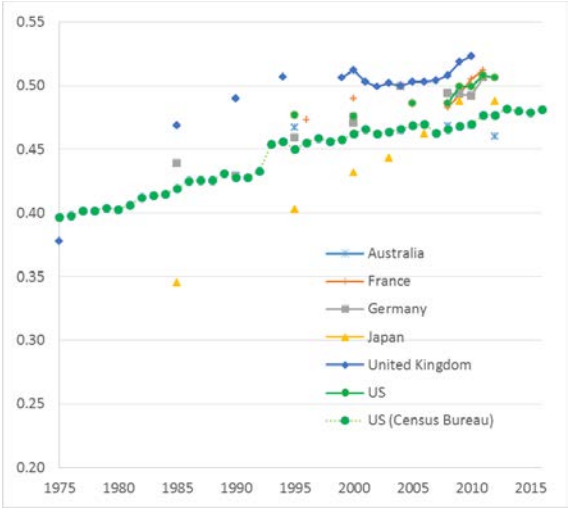
Source: IMF *World Economic Outlook*, October 2017.

Figure 4: Real Equilibrium Interest Rate, % per year



Source: Holston et al. (2018) and San Francisco Fed.

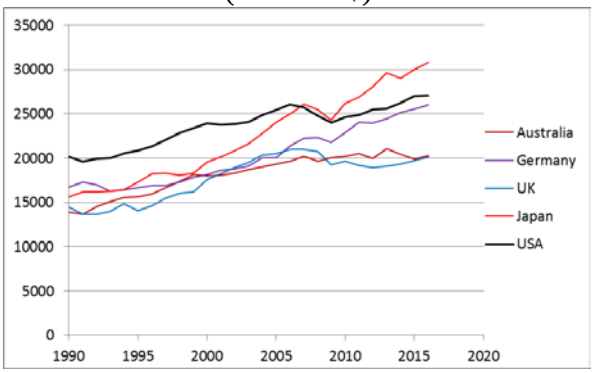
Figure 5. Income Gini Coefficients, Key OECD Countries



Sources: Unless otherwise stated, OECD Income Distribution Database (OECD 2017). The single continuous series is from the U.S. Census Bureau, Current Population Survey, Annual Social and Economic Supplements.

Figure 6: Real Net National Product per Capita

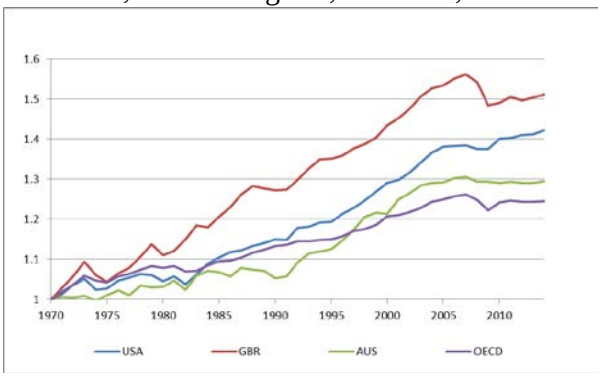
(1990 US$)



Sources: Deflation is by CPI from IMF: *World Economic Outlook*. NNP values are from the OECD: *National Accounts Statistics*.

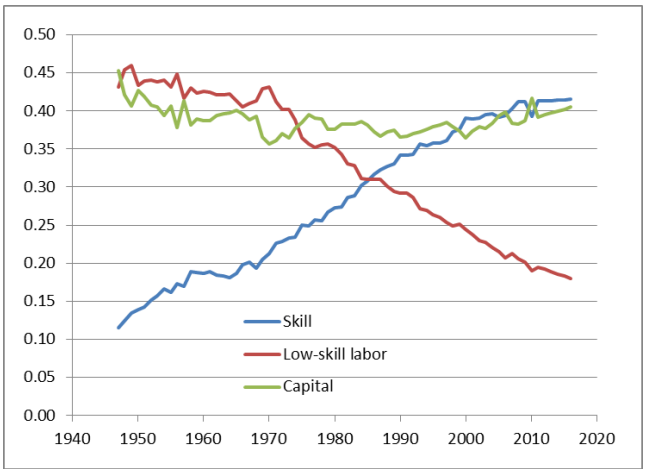
Figure 7. Total factor productivity, 1970-2014

(United States, United Kingdom, Australia, OECD overall)



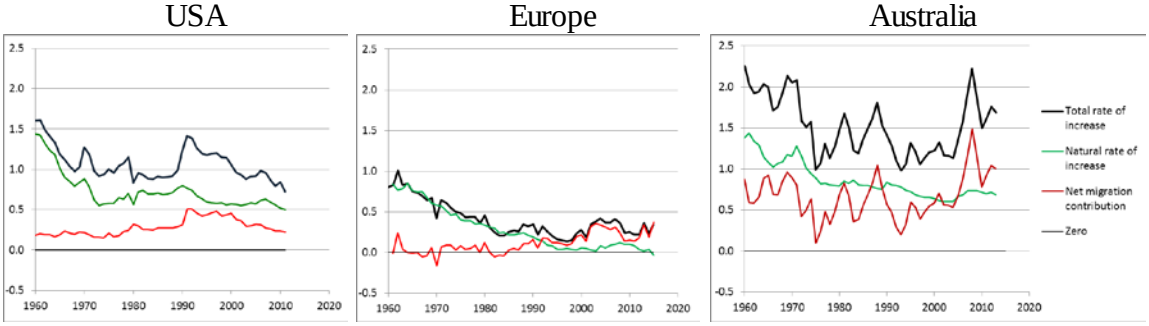
Source: Penn World Tables, international comparisons of production, income and prices, version 9.0. TFP is the portion of output change not explained by the quantities of inputs used in production and is reported at constant national prices (2011=1). We normalize the data to set TFP in 1970 at unity.

Figure 8. Factor Shares of Value Added in the US



Source: Authors' calculations based on the Penn World Tables (Feenstra et al. 2015) and Socio Economic Accounts, World Input Output Database, 2013 Release (Timmer et al. 2015), along with employment and wage data from FRED. Solid lines indicate historical data. Broken lines indicate extrapolations used in the prospective analysis.

Figure 9: Population Growth in the US, Europe and Australia (% per year)



Source: European Commission, Eurostat Population and Population Change Statistics.

Table 1. Inequality Associated with Prospective Deflationary Forces[a]

(Annual % change in real purchasing power at consumer prices of household group disposable income)

Deflationary force	Household	USA	EU	Japan	China	Australia
Automation[b]	Low skill	-0.92	-0.43	-0.95	-0.54	-0.82
	Skilled	0.62	1.11	0.59	1.01	0.72
	Capital owning	1.32	1.82	1.29	1.75	1.42
	Low-skill to capital owning gap	2.24	2.25	2.24	2.28	2.24
Company tax rate reductions[c]	Low skill	0.03	0.09	-0.02	-0.13	0.03
	Skilled	0.03	0.09	-0.02	-0.13	0.03
	Capital owning	0.27	0.37	0.22	0.26	0.28
	Low-skill to capital owning gap	0.23	0.28	0.25	0.39	0.26
Migration[d]	Low skill	-0.05	-0.12	0.07	0.15	-0.40
	Skilled	-0.05	-0.12	0.07	0.15	-0.40
	Capital owning	0.25	0.28	0.06	0.15	0.59
	Low-skill to capital owning gap	0.30	0.40	0.00	0.00	1.00
Total of the three forces	Low skill	-0.93	-0.46	-0.91	-0.51	-1.20
	Skilled	0.60	1.08	0.63	1.03	0.34
	Capital owning	1.84	2.47	1.58	2.16	2.30
	Low-skill to capital owning gap	2.78	2.94	2.48	2.67	3.50

a These changes in household real disposable incomes arise from a global model simulation in which migration, company tax rates and automation shocks are imposed. Zero inflation targeting monetary policy regimes are assumed to be maintained in all regions except China and the "rest of the world", which target their US$ exchange rates, and the results shown are specific to the nominated shocks only. Inflation expectations are anchored by the zero targets in the advanced economies and are model consistent in the others. No underlying growth process is included but the capital flows and capital stock adjustments that occur in response are included.

b The automation shock is a fall in the low-skill labour share of total value added in each region by 1.53 %/year, which is the rate at which the share in the US has decline during the past two decades (Tyers and Zhou 2017). This rate is here imposed in all regions without any associated changes in TFP.

c The company tax shock is a one-off, uniform reduction in the *power* of the capital income tax rate, in all regions, by 5.0 %, implemented over 10 years. Lost government revenue is assumed to be made up via increases in consumption tax rates. Results for a US only shock are more modest, though the US deflationary force is stronger due to exchange rate appreciation. These results are available on request.

d The migration shock raises the low-skill labour force of the US by 0.3 %/year, that of the EU by 0.4 %/year and that of Australia by 1.0 %/year with this labour being deducted from the labour force of the "rest of the world". The same proportional changes are applied to their skilled work forces, though these increments are not deducted from the "rest of the world" under the assumption that its brain drain stimulates training into the lost positions. Note that the changes listed indicate identical effects on the low-skilled and the skilled. This is because the proportional changes in supply are the same for these two categories.

Table 2. Prospective Deflationary Forces: Simulated Real Long Bond Yield Changes[a]
(Annual % change)

Deflationary force	USA	EU	Japan	China	Australia	Rest of World
Automation[b]	-0.97	-0.97	-1.09	-0.99	-0.95	-1.07
Capital tax rate reduction[c]	-0.41	-0.39	-0.42	-0.48	-0.37	-0.68
Migration[d]	-0.38	-0.42	-0.35	-0.32	-0.50	-0.34
Combined shocks	-1.76	-1.78	-1.86	-1.79	-1.82	-2.09

a These are proportional changes in long bond yields (not % point or basis point changes) arising from a global model simulation in which migration, company tax rate and automation shocks are imposed. Zero inflation targeting monetary policy regimes are assumed to be maintained in all regions except China and the "rest of the world", which target their US$ exchange rates, and the results shown are specific to the nominated shocks only. Inflation expectations are anchored by the zero targets in the advanced economies and are model consistent in the others. No underlying growth process is included but the capital flows and capital stock adjustments that occur in response are included.

b The automation shock is a fall in the low-skill labour share of total value added in each region by 1.53 %/year, which is the rate at which the share in the US has declined during the past two decades (Tyers and Zhou 2017). This rate is here imposed in all regions without any associated changes in TFP.

c The company tax shock is a one-off, uniform reduction in the *power* of the capital income tax rate, in all regions, by 5.0 %, implemented over 10 years. Lost government revenue is assumed to be made up via increases in consumption tax rates. Results for a US only shock are more modest, though the US deflationary force is stronger due to exchange rate appreciation. These results are available on request.

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Table 3. Prospective Deflationary Forces: Simulated Changes in Money Demand by Source[a]
(Annual % change)

Deflationary force	Observed variable	USA	EU	Japan	China	Australia
Automation[b]	Money growth rate, %/yr	**1.8**	**2.1**	**1.7**	**2.0**	**1.9**
	% due to goods & services transactions	15	14	13	23	15
	% due to portfolio expansion	54	58	58	53	55
	% due to portfolio rebalancing	31	28	29	25	31
Company tax rate reductions[c]	Money growth rate, %/yr	**0.2**	**0.2**	**0.1**	**0.4**	**0.2**
	% due to goods & services transactions	10	12	7	20	9
	% due to portfolio expansion	42	46	41	47	42
	% due to portfolio rebalancing	48	43	52	33	49
Immigration[d]	Money growth rate, %/yr	**0.6**	**0.6**	**0.4**	**0.6**	**1.1**
	% due to goods & services transactions	25	26	5	9	39
	% due to portfolio expansion	42	44	44	39	42
	% due to portfolio rebalancing	34	30	51	51	19
Total of the three forces	Money growth rate, %/yr	**2.7**	**3.0**	**2.2**	**3.1**	**3.2**
	% due to goods & services transactions	22	23	7	13	35
	% due to portfolio expansion	44	47	48	43	44
	% due to portfolio rebalancing	33	30	45	45	21

a These changes in monetary bases arise from a global model simulation in which migration, company tax rate and automation shocks are imposed. Zero inflation targeting monetary policy regimes are assumed to be maintained in all regions except China and the "rest of the world", which target their US$ exchange rates, and the results shown are specific to the nominated shocks only. Inflation expectations are anchored by the zero targets in the advanced economies and are model consistent in the others. Positive growth in monetary bases indicates the expansions required in order to sustain the targets, showing the strength of the associated deflationary forces. No underlying growth process is included but the capital flows and capital stock adjustments that occur in response are included.

b The automation shock is a fall in the low-skill labour share of total value added in each region by 1.53 %/year, which is the rate at which the share in the US has declined during the past two decades (Tyers and Zhou 2017). This rate is here imposed in all regions without any associated changes in TFP.

c The company tax shock is a one-off, uniform reduction in the *power* of the capital income tax rate, in all regions, by 5.0 %, implemented over 10 years. Lost government revenue is assumed to be made up via increases in consumption tax rates. Results for a US only shock are more modest, though the US deflationary force is stronger due to exchange rate appreciation. These results are available on request.

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