Downshifting in the Fast Lane: A post-Keynesian Model of a Consumer-led Transition

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Abstract

If the world's countries seriously tackle the climate targets agreed in Paris, their citizens are likely to experience substantial changes in production, consumption and employment. This paper describes a long-run post-Keynesian model that is being built to better understand the potential implications of a major transition on macroeconomic stability and employment. It is a demand-led model in which firms have considerable freedom to administer prices, while consumers are unable to change consumption rapidly. Firms continually seek input-saving technological improvements that, in the aggregate, tie technological progress to firms' cost structure. Together with firm pricing strategies and wage setting, the productivities of different inputs determine the functional income distribution. Saving and investment, and production and purchase of consumption goods, are undertaken by different economic actors, driven by income and capacity utilization, with the possibility that productive capacity exceeds, or falls short of, effective demand. As with other post-Keynesian models, insufficient effective demand can result in unemployment and below-normal utilization of productive capital, even for extended periods. We show that the model produces business cycles and long waves driven by technological change. We present preliminary results for a “downshifting” scenario in which households voluntarily withdraw labor and discuss the implications of downshifting for stability, growth, and employment. We contrast the downshifting scenario with ones in which households reduce consumption without withdrawing from the labor pool.

Keywords: demand-led growth; downshifting; Kaleckian-Harrodian; post-Keynesian; ecological economics

JEL: E11, E12, O41, Q01; Q56

1 Introduction

Shifting to a low-carbon economy is vital to limiting global temperature and curbing dangerous levels of climate change. World leaders committed themselves to climate action when over 195 countries[1] signed the historic Paris Agreement and pledged to take appropriate climate mitigation actions[2] to restrict global temperature increases to below 1.5°C[3]. However, proposed country actions submitted as of November 2016 are insufficient to meet the temperature limit[4]. Ultimately, to prevent further warming, it will be essential to keep most of the remaining fossil fuels in the ground[5]. Because fossil fuel consumption has underpinned human development in the last two centuries, there is great reluctance to transition to different fuels.

Given the urgency of the climate challenge, the question before us is, how can we accelerate a low-carbon transition? Recommendations tend to focus on technological choice and investment[6], yet there are reasons to think that major societal and lifestyle changes must accompany a low-carbon transition. After all, prior technological transitions led to major changes[7]. If the transition is to be intentional, and rapid, it raises a question: should producers lead, consumers lead, or must both change together?

In this paper we focus on middle- to high-income households in high-income countries in their roles as workers and consumers. Given global constraints on human activity – planetary boundaries[8] – and a finite carbon budget[9], equity considerations imply a need for reduced physical throughput in high-income economies. The continued close association between GDP and material and energy flows[10] suggests we must make quality of life depend on more than GDP[11], allowing GDP growth to slow and perhaps even fall for a time in high-income countries[12]. Schor[13] argues that reduced working hours in high-income countries, or "downshifting", is a strategy to address the "triple imperative" of reducing pressure on the environment, global poverty, and erosion of social capital in the course of economic development.

According to Schor[14], downshifting is "a quiet shift in values and behaviors away from consumerism. Downshifters either withdraw or partially withdraw from the labor force, mainly in order to achieve more balance, control and less stress in life". It is a strategy open to comparatively wealthy households and is motivated mainly by concerns over quality of life, rather

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[1] UNFCCC, "Paris Agreement - Status of Ratification."

[2] "According to Article 4 paragraph 2 of the Paris Agreement each Party shall prepare, communicate and maintain successive nationally determined contributions (NDCs) that it intends to achieve. Parties shall pursue domestic mitigation measures, with the aim of achieving the objectives of such contributions."

[3] UNFCCC, "Paris Agreement."

[4] Climate Action Tracker, "Effect of Current Pledges and Policies on Global Temperature."

[5] McGlade and Ekins, "The Geographical Distribution of Fossil Fuels Unused When Limiting Global Warming to 2 °C"; Benedikter et al., "'Keep It in the Ground.' The Paris Agreement and the Renewal of the Energy Economy."

[6] UNEP, *Towards a Green Economy*; OECD, "Towards Green Growth: A Summary for Policy Makers"; Green Growth Action Alliance, "The Green Investment Report: The Ways and Means to Unlock Private Finance for Green Growth."

[7] Rhodes, "Energy Transitions"; Bridge et al., "Geographies of Energy Transition."

[8] Rockström et al., "Planetary Boundaries: Exploring the Safe Operating Space for Humanity."

[9] Messner et al., "The Budget Approach."

[10] Ayres and Warr, *The Economic Growth Engine*.

[11] E.g., Victor, *Managing without Growth*; Jackson, *Prosperity without Growth*.

[12] Kallis, Kerschner, and Martinez-Alier, "The Economics of Degrowth."

[13] Schor, "The Triple Imperative."

[14] Ibid., 14.

than the environment. Nevertheless, it may have environmental benefits[15], particularly among the households with the largest environmental footprints.

Reducing working hours means less expenditure and less output. The same effect can be achieved by simply buying less, without reducing working hours. However, as we illustrate with the model described in this paper, the effects of the two strategies are quite different. Buying less without working less means higher savings, but also less incentive for companies to invest. This results in unemployment, but not immediately, and almost certainly not for the household that first curtailed its consumption. Reducing working hours, on the other hand, combines reduced employment with reduced expenditure within the same household.

We present scenarios of downshifting and reduced consumption using a model that is being developed in order to better understand the dynamics of a transition to a low-carbon economy. The model is in active development, but is already yielding some interesting results. In this paper we present the model in words, with only one equation. A mathematical presentation of the model, now slightly out of date, can be found in a separate paper[16].

2 Methods

We draw on several theoretical traditions, while remaining broadly within post-Keynesian economics[17]. We follow ecological economics in viewing economies as open systems embedded in societies, which are embedded in nature[18]. From evolutionary economics we draw the idea that economies are normally out of equilibrium[19], and from Blatt[20] that the average state of the economy may differ substantially from the equilibrium. Following a long tradition in economics[21], we view the future as fundamentally uncertain, a central concept in post-Keynesian economics[22]. Because of uncertainty, economic actors' beliefs about the future significantly influence the trajectory of the economy[23]. Theoretical and empirical work in post-Keynesian economics demonstrates the importance of demand, as well as supply, to long-run growth[24]. Moreover, demand and supply co-evolve[25]. With the Sraffians[26], we agree that changes in the sectoral composition of production and consumption are relevant to long-term growth, and that the distribution of income between profits and wages is influenced by wider social forces. Both the evolutionary and post-Keynesian perspectives emphasize the historically contingent and path-dependent nature of economic change.

We follow a general approach to macroeconomic modeling[27], in which a set of economic balances, or accounts, is supplemented by behaviors of economic actors. Once actors have acted, the accounts are typically out of balance, so some parameter or combination of parameters

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[15] Kennedy, Krahn, and Krogman, "Downshifting."

[16] Kemp-Benedict, "A Multi-Sector Kaleckian-Harrodian Model for Long-Run Analysis."

[17] Lavoie, *Post-Keynesian Economics: New Foundations*.

[18] Costanza et al., "Building a Sustainable and Desirable Economy-in-Society-in-Nature."

[19] Schumpeter, "The Instability of Capitalism"; Nelson and Winter, *An Evolutionary Theory of Economic Change*.

[20] Blatt, "Economic Policy and Endogenous Cycles."

[21] Knight, *Risk, Uncertainty and Profit*; Keynes, *The General Theory of Employment, Interest, and Money*; Shackle, "Probability and Uncertainty."

[22] Davidson, "Is Probability Theory Relevant for Uncertainty?"; Dunn, "Bounded Rationality Is Not Fundamental Uncertainty."

[23] Beckert, *Imagined Futures: Fictional Expectations and Capitalist Dynamics*.

[24] Setterfield, *The Economics of Demand-Led Growth*.

[25] Witt, *Escaping Satiation: The Demand Side of Economic Growth*.

[26] Aspromourgos, "Sraffian Research Programmes and Unorthodox Economics."

[27] Adapted from Taylor, *Reconstructing Macroeconomics: Structuralist Proposals and Critiques of the Mainstream*.

must adjust to clear the accounts. Once all of the accounts, behaviors and clearing mechanisms are specified, the model is closed, meaning that all variables are either specified externally (the "exogenous" variables) or computed (the "endogenous" variables), with none left free.

Because models must be closed, fundamental uncertainty and openness pose a challenge. But they are features of the real world – indeed, the very features that make a low-carbon transition imaginable. We follow Setterfield[28] by treating behaviors and clearing mechanisms as conditional, dependent on both the research question and on historically contingent features of the economy. This approach combines well with a scenario analysis[29]. To be useful, a scenario model must be flexible enough to represent different narratives while representing relevant systems sufficiently well to keep the scenarios within the wide but finite bounds of what can realistically be posited about alternative futures[30]. In the accounts-behaviors-clearing mechanisms approach to model-building, different scenarios can be distinguished by different behavioral assumptions and pathways for exogenous variables. They may also differ in the way the accounts are cleared. More rarely, the accounts themselves may change.

3 Model design

The essential components of the model are shown in Figure 1. In its present form it has five productive sectors: services, construction, manufacturing, agriculture, and mining. It is a closed economy model with no government sector. The model is demand-led, adjusting gradually through changes in capital and labor productivity, pricing decisions of firms, wage-setting, and capital accumulation.

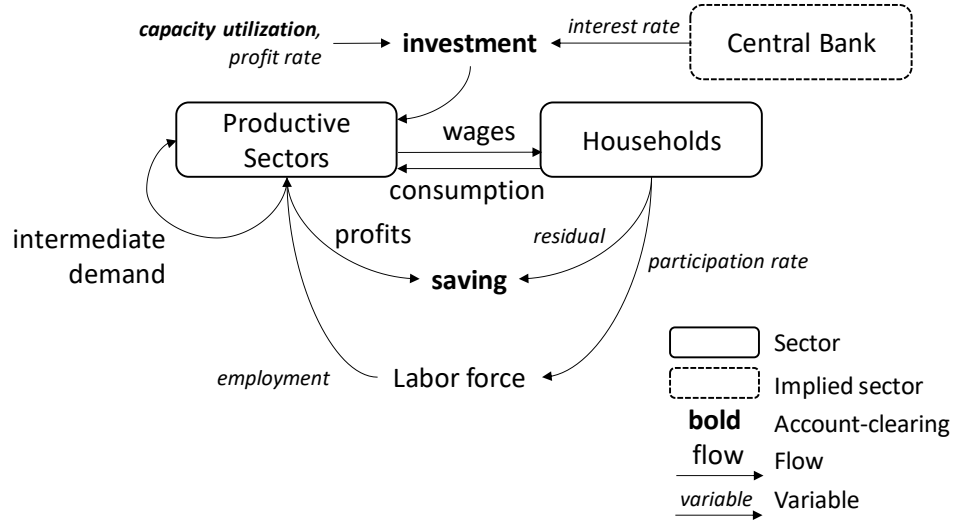

Figure 1: Main components, their interactions, and key variables

3.1 Saving and investment

In keeping with post-Keynesian theory[31], separate decisions govern saving and investment, so they are typically out of balance once actors have acted. The accounts are cleared by adjusting capacity utilization. The model thus allows for underutilization of capital and unemployment. We assume that all profits are saved, so although those profits may be retained by firms or paid to

[28] Setterfield, "Critical Realism and Formal Modelling: Incompatible Bedfellows?"
[29] Bishop, Hines, and Collins, "The Current State of Scenario Development: An Overview of Techniques."
[30] Bell, *Foundations of Futures Studies: Human Science for a New Era*.
[31] Lavoie, *Post-Keynesian Economics: New Foundations*.

households, in Figure 1 we show profits as a direct line from the productive sectors to saving. Households may also save, or borrow, in an amount determined by the gap between their wage income and their consumption.

Investment is determined by an investment function. When capital stocks are operating at relatively high capacity, it is a signal to firms that more investment is needed; conversely, when utilization is low it is a signal to slow down investment. Investment funds come implicitly from retained profits, bank loans, or equity investment. Equity investors responds to returns. While the model has no government sector, it implicitly includes a central bank, which sets an interest rate. Higher interest rates mean higher borrowing costs, which discourage firms from taking on bank loans. The investment rate (that is, new investment divided by the value of the capital stock) is therefore an increasing function of both capacity utilization and the profit rate and a decreasing function of the interest rate.

3.2 Economic growth

Growth in economic output is driven mainly by population growth and change in labor productivity. The influences on output can be seen from the following equation,

$$\underbrace{\text{output}}_{\text{GDP}} = \mathbf{population} \times \frac{\text{working-age}}{\text{population}} \times \underbrace{\frac{\text{labor force}}{\text{working-age}}}_{\text{participation rate}} \times \underbrace{\frac{\text{employed labor}}{\text{labor force}}}_{\text{employment rate}} \times \underbrace{\frac{\mathbf{output}}{\mathbf{employed\ labor}}}_{\mathbf{labor\ productivity}}.$$

Population in the model is calculated using a three-cohort demographic model, in which the working-age population (cohort 2) has children (cohort 1), most of whom eventually grow up to join the workforce, and eventually retire (cohort 3). The model also allows for immigration into the working-age cohort and death in all three cohorts.

Labor productivity is increased mainly through the use of labor-saving (and resource-using) machines. Thus, labor productivity growth is driven largely (although not entirely) by capital accumulation. The model combines cost-share induced technological change with a conventional post-Keynesian assumption that labor productivity growth increases with the pace of capital accumulation (the Kaldor-Verdoorn law)[32]. In cost-share induced technological change models, a rise in the cost share for one input to production (say, labor) stimulates faster productivity growth in that input, while potentially slowing productivity growth in another input. Such a model can explain the historically observed combination of rising labor productivity with variable, but trendless, capital productivity[33].

3.3 Stability, connection, and coordination

Orders for investment goods increase capacity utilization and employment, so utilization depends positively on investment. But as we earlier assumed that investment depends positively on utilization, the model contains a positive feedback loop, which can be unstable. While post-Keynesian theorists conventionally assume parameter values that guarantee stability, we consider the evidence to favor instability[34]. Technically, this means that the model is of the Kaleckian-Harrodian type[35]. The instability is contained from above because capital cannot be more than fully utilized. It is contained from below because the rate of disinvestment is limited by

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[32] Ibid., 428–30.

[33] Kemp-Benedict, "Biased Technological Change and Kaldor's Stylized Facts."

[34] See the discussion in Kemp-Benedict, "A Multi-Sector Kaleckian-Harrodian Model for Long-Run Analysis," 3–4.

[35] Skott, "Growth, Instability and Cycles: Harrodian and Kaleckian Models of Accumulation and Income Distribution."

the depreciation rate of capital. The result is a multiplier-accelerator model contained by a ceiling and floor[36].

Counterintuitively, the unstable dynamics help to coordinate activity in different sectors. The productive sectors are connected to one another through investment, the consumption expenditure of their employees, and intermediate demand. Following post-Keynesian theory[37], each sector sets its prices as a mark-up on its costs; because expenditure on intermediate goods is a cost, prices in different sectors are interrelated[38]. Nevertheless, these *connections* are not enough to ensure that production plans in different sectors are *coordinated*. There is no guarantee that the combination of household demand, demand for investment goods, and intermediate demand will lead to balanced production[39].

The coordinating role of the utilization ceiling in the model is illustrated with an analogy to boats at a dock in Figure 2. When the tide is coming in, the boats are pushed against the dock. They line up, but not because they coordinate their movements; rather, it is because the dock prevents them from going further. When the tide goes out, each boat drifts away from the dock at a rate determined by the currents and eddies where it is located. The boats are no longer neatly lined up, but the disarray lasts only until the next time the tide comes in. The analogy is imperfect, because sectors are connected, even if they are not coordinated. (To stretch the analogy, as a boat moved it would tend to entrain the other boats.)

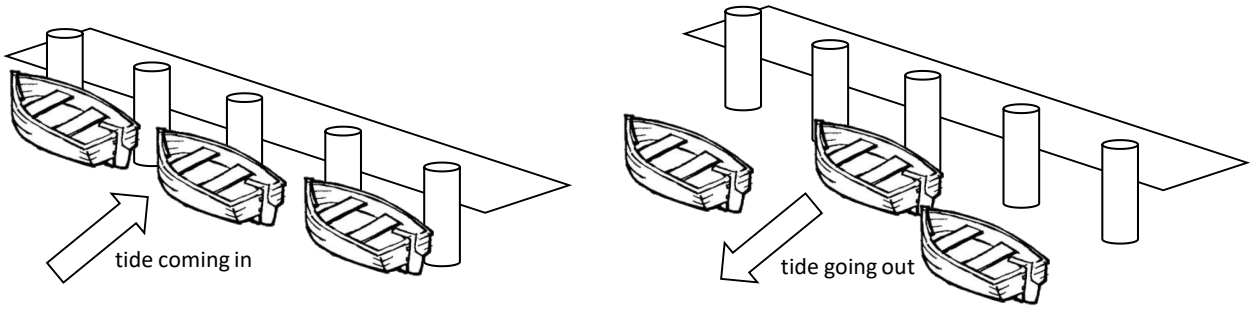

Figure 2: Boats at a dock as an analogy for an unstable dynamic with an upper bound

In the model, the ceiling in the multiplier-accelerator model periodically lines sectors up, like the boats at the dock in Figure 2. When the utilization ceiling is reached in one sector, investment is high but consumption plans are frustrated, leading to under-consumption in other sectors. The fall in consumer demand leads to a fall in utilization, which leads to a fall in investment demand, which is only turned around because the fall in investment is halted by the floor of capital depreciation. In the trough of the business cycle, some firms postpone investment, while others continue to invest in expectation of a recovery. If that investment is sufficient, utilization eventually returns close to normal levels. Investment increases with utilization, and the recovery turns into a boom that continues until the utilization ceiling is reached once again.

Firms' expectations of future growth are informed by their experience of past growth, so as the business cycle is repeated, investment and consumption patterns gradually align. When the structure of the economy changes, those patterns are disturbed, but they eventually re-align over

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[36] Hicks, *A Contribution to the Theory of the Trade Cycle*.

[37] Coutts and Norman, "Post-Keynesian Approaches to Industrial Pricing."

[38] Abraham-Frois and Berrebi, *Prices, Profits and Rhythms of Accumulation*; Aspromourgos, "Sraffian Research Programmes and Unorthodox Economics"; Kemp-Benedict, "Dynamic Stability of Post-Keynesian Pricing."

[39] Pasinetti, *Structural Change and Economic Growth*.

time if expectations of future growth are sufficiently buoyant[40] to push utilization rates to the ceiling. If they are not sufficiently buoyant, then the economy can go into a prolonged slump, with utilization rates falling to different degrees in different sectors. In Figure 2, this corresponds to the failure of the incoming tide. Without that coordinating force, the boats drift ever farther from the dock.

3.4 Wages

For wage setting, we adopt the Goodwin[41] model, which ties changes in the real wage to labor productivity gains and unemployment. At normal levels of unemployment, wage rates rise at the same rate as productivity. They rise more slowly than labor productivity when unemployment is high and more quickly when unemployment is low. Unlike Goodwin, we express money wages in nominal terms. Wage raises are applied to current rates, followed by a cost of living adjustment that anticipates inflation. As it is difficult to negotiate a reduction in nominal wage rates, we apply the cost of living adjustment only if inflation is positive.

Each sector has some flexible and some inflexible labor. Flexible labor is laid off and re-hired over the course of a business cycle, while inflexible labor is maintained. Employed labor is drawn from and released into the labor force; that is, the working-age population that is participating in the labor market. The unemployment rate depends on the number of working-age people participating in the labor force. We assume the participation rate follows the unemployment rate with a lag. When unemployment is persistently high, job seekers become discouraged and exit the labor force. When unemployment falls, more of the working-age population is drawn into the labor force, but with a delay as they learn about changed conditions in the labor market, adjust routines at home, and refresh skills.

3.5 Prices and inflation

Most prices in modern economies are administered[42]. This observation underpins post-Keynesian pricing theory[43], in which most sectors are dominated by a few large firms (oligopoly) that set their prices as a mark-up on costs to generate profits. However, they do not have complete freedom, because excessive profits encourages entry by rival firms. There is competition under oligopoly, sometimes quite fierce, but as price wars are damaging to all firms, it is mainly carried out on such non-price dimensions as reputation, new products or features, and customer relations.

In the model, total costs are equal to labor costs plus the cost of intermediate inputs purchased from other sectors. Tracking intermediate costs through the network of inter-sectoral exchanges, each sector's costs can be expressed in terms of wage costs across its supply chains[44]. Thus, wage costs ultimately determine prices. Inflation occurs when wages rise faster than labor productivity[45]. This introduces a circularity in the model. The wage-setting procedure described earlier occurs in two steps: first, the intended real wage increases faster or slower than labor productivity depending on the unemployment rate; then a correction is added for anticipated inflation. But the reason inflation occurs in the first place is that wages rise faster than labor productivity.

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[40] Kaldor, "A Model of Economic Growth," 601.

[41] Goodwin, "A Growth Cycle."

[42] Means, *Industrial Prices and Their Relative Inflexibility*; "The Administered-Price Thesis Reconfirmed."

[43] Lee, *Post Keynesian Price Theory*; Coutts and Norman, "Post-Keynesian Approaches to Industrial Pricing."

[44] Pasinetti, "The Notion of Vertical Integration in Economic Analysis."

[45] Firm costs include more than wages and costs of intermediates. Of particular importance for sustainability studies, raw materials costs also enter into firm costs, and can also drive inflation. We defer adding raw materials costs to a later version of the model.

The ultimate source of inflation in the baseline scenario is the unstable investment dynamics. During an expansion, there is increased demand for investment goods, and therefore labor in the sectors that produce those goods. Those workers spend their incomes, generating demand for more goods, feeding the expansion and driving inflation. Because inflation ultimately comes from investment decisions, it can be moderated by influencing investment. This is accomplished in the model by tying the interest rate (which enters the investment function) to the inflation rate through a "Taylor rule"[46].

3.6 Consumption

A substantial amount of household expenditure is routine: locked in through contracts or the costs of operating durable commodities; constrained by the location of home, work and school; or imposed by physiological necessity. In the 2014 US Consumer Expenditure Survey,[47] two-thirds of all household expenditure was on housing, transportation, food, or apparel and related services. The implication is that less than half of expenditure is flexible in the short run, helping to stabilize the economy during the contraction phase of the business cycle. Over longer time scales, households expand their consumption as their incomes rise. In the model we capture the combination of long-run expansion and short-term inflexibility by assuming that a component of consumption expands with total wages at normal utilization, while a further component varies over the business cycle as realized wage income falls and rises.

3.7 Active and inactive capital

When the economy of a country or region fails, it is left with the shuttered buildings and sometimes the machinery of the businesses that had once provided employment. Those buildings and equipment are still accounted for as part of capital stocks through prior investment, but they are not simply underutilized in the trough of the business cycle. They are inactive, and might not be reactivated.

In the model, we account for inactive capital by moving some underutilized capital into an "inactive" category. When investment picks up again, some of that investment is met by reactivating inactive capital. In the baseline scenario, the fraction of inactive capital is negligible. It is more relevant to scenarios in which economic output grows much less quickly, or shrinks.

4 Model behavior in the baseline scenario

The model described above has multiple, interacting dynamics. Many of them are stable when acting on their own, but operate with delays. Systems with these features typically show cyclical behavior. Other dynamics, such as population or labor productivity growth, are always pushing upward, while investment dynamics are locally unstable, but bounded by a ceiling and a floor. We populated the model using a combination of values based on US data, typical values from the literature, and values calibrated to give persistent business cycles in the baseline scenario.

4.1 Structural change

In the model, labor productivity growth differs between sectors, while expenditure shares per unit wage and per unit of capital investment are held fixed. As a result, sectoral value added as a share of GDP is nearly constant in the baseline scenario, while employment shares change dramatically. When either labor productivity or expenditure shares (or both) change at different rates in different sectors, full employment is not guaranteed[48]. In the model, a long-run balance is maintained through interactions between employment, wages, prices, and productivity growth.

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[46] After Taylor, "Discretion versus Policy Rules in Practice."

[47] http://www.bls.gov/cex/

[48] Pasinetti, *Structural Change and Economic Growth*, 87.

4.2 Business cycles

The model produces asymmetric business cycles, as observed in the US economy. As shown in Figure 3, the business cycle in the model, as measured by utilization, falls rapidly (over 3 quarters) and then rises slowly (over 19 quarters). This compares favorably to the post-World War II business cycle average of 4 quarters of contraction and 19 quarters of expansion.[49] In the terminology of Sichel[50], the cycle in Figure 3 is both steep and deep. In fact, Sichel found evidence of steepness and deepness only for unemployment in the US, and not for other macroeconomic indicators. In our model, in its present form, capacity utilization, GDP and unemployment move together, so the model must be extended if it is to explain different patterns in different variables.

A notable feature of Figure 3 is that no cycle is a precise copy of another, although they are qualitatively similar. Partly this is because the model advances in discrete time steps (it is calculated each quarter), but partly it is because the cycles result from multiple interacting processes, each with its own characteristic time scale. The cycle for construction lags the cycles in other sectors, because orders are placed for investment goods before they are actually built.[51] In keeping with the "boats at the dock" analogy illustrated in Figure 2, all sectors other than construction converge on a similar utilization rate close to the peak, but fall to different degrees in the trough and recover at different rates.

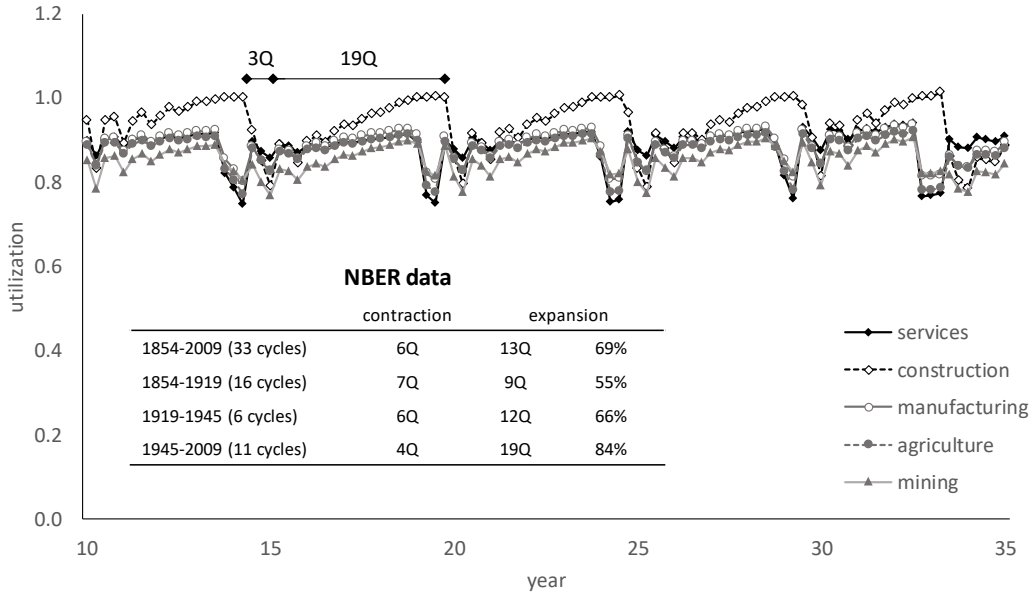

Figure 3: Business cycles in the baseline scenario, with data from the National Bureau of Economic Research

[49] As dated by the National Bureau of Economic Research (http://www.nber.org/cycles.html)

[50] Sichel, "Business Cycle Asymmetry."

[51] Utilization in the construction sector slightly exceeds a value of one at the peak. This is allowed in the model because utilization is conventionally measured relative to maximum sustainable levels of production. It is possible to slightly exceed sustainable levels for short times.

4.3 Long waves

Underlying the business cycle are much longer cycles, of about 43 years. We are tempted to identify these as Kondratieff long waves[52], which are estimated to last between 35 and 60 years[53]. The source of the waves in the model is the interaction between technological change, pricing, and employment and wages. Rising employment and wages drive labor costs up. Because prices respond after a delay, this shifts the distribution of income away from profits and towards wages, stimulating labor productivity growth and dampening capital productivity growth. The combination reduces pressure on employment and wages, but also drives the profit rate down. Firms respond by raising their mark-ups, driving the income distribution towards profits and away from wages, encouraging faster capital productivity growth and slower labor productivity growth. The cycle then repeats. Consistent with observation, capital productivity changes over time, but has no clear trend, as the capital productivity growth rate cycles around a value of zero.

5 Model behavior in alternative scenarios

As discussed in the introduction, we contrast downshifting, or reducing working hours, with reduction in consumption without reducing labor. In each scenario, we represent a transition as a change in a model parameter that starts in year 100 (to allow some transient behavior to work itself out) and continues for 25 years. We chose values that pushed the model close to a critical level, or just beyond it. In a *downshifting* scenario we reduce the effective size of the working age population by 40% over the time period, which leads temporarily to no GDP growth. In two *reduction* scenarios we reduce consumption per unit wage by either 7.5% or 15% over the same time period. In the former scenario, the economy continues, while in the latter it enters a deep slump.

In the following set of graphs we show the model behavior between years 75 and 150. The labor force is shown in Figure 4. The effect of reduced working hours in the *downshifting* scenario is evident in the figure. In the *7.5% reduction* scenario employment rises above the baseline after a delay, while it falls off precipitously in the *15% reduction* scenario.

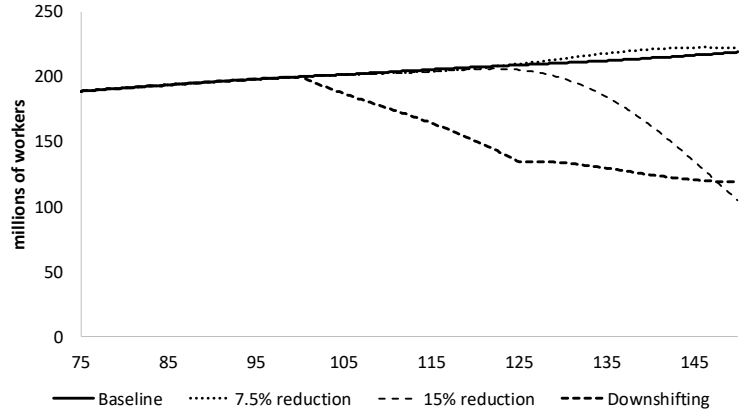

Figure 4: Labor force

The effect on consumption is shown in Figure 5. Relative to the *baseline* scenario, consumption actually rises slightly in the *downshifting* scenario before it drops gradually to less than half the baseline level. In the *15% reduction* scenario, consumption falls as the economic engine fails. In

[52] Kondratieff, "The Long Waves in Economic Life."
[53] Metz, "A Re-Examination of Long Waves in Aggregate Production Series."

contrast, in the *7.5% reduction* scenario, consumption not only recovers, it overshoots relative to the baseline.

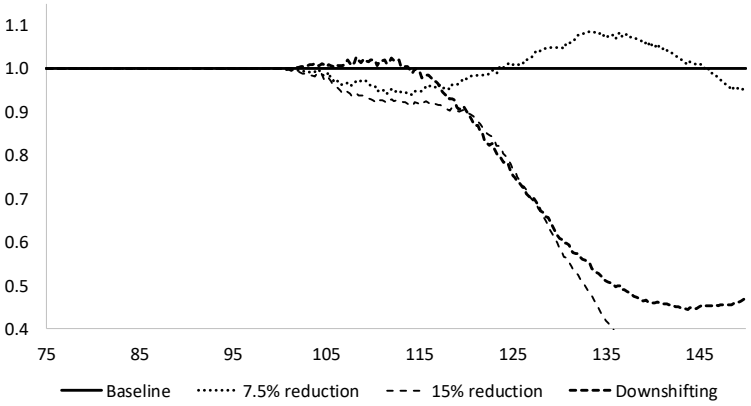

Figure 5: Real consumption relative to baseline

The trajectory of GDP in the scenarios is shown in Figure 6. As seen in the figure, GDP does not grow in the *downshifting* scenario between year 115 and 135. After that it begins to pick up again. The 10-year lag between the reduction in work hours and the flattening of GDP is a result of multiple interacting dynamics in the model. In the *7.5% reduction* scenario, GDP, like consumption, actually rises above the baseline level for a time, while GDP collapses in the *15% reduction* scenario.

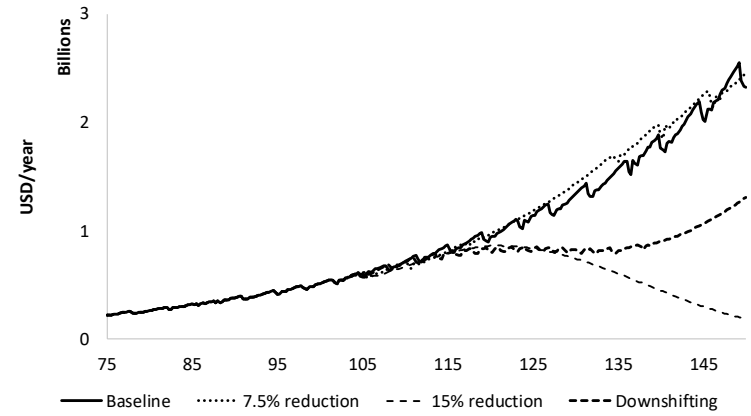

Figure 6: Real GDP

The *downshifting* scenario has the interesting effect of driving inflation, as seen in Figure 7. This happens because firms are unaware of the cultural phenomenon of downshifting and are making their investment and production plans based on past experience. Because less labor is available, it pushes wages up sharply. In contrast, when consumption is reduced without withdrawing labor in the two *reduction* scenarios, there is modest deflation. This deepens sharply in the *15% reduction* scenario and recovers and then overshoots in the *7.5% reduction* scenario.

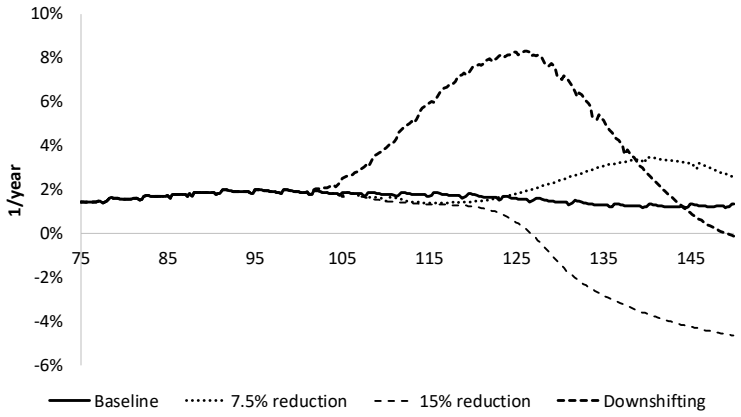

Figure 7: Consumer price inflation rate

Higher labor costs in the *downshifting* scenario stimulate investment in labor-saving technology, as seen in the graph of manufacturing labor productivity growth shown in Figure 8. The result is an increase in the capital-to-labor ratio, as shown in Figure 9. That is, in the *downshifting* scenario, as employment and output fall, the economy shifts towards labor-saving and more capital-intensive forms of production.

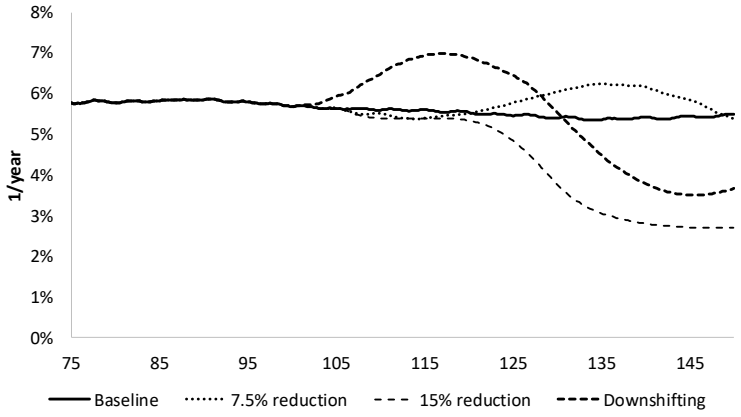

Figure 8: Labor productivity growth rate in manufacturing

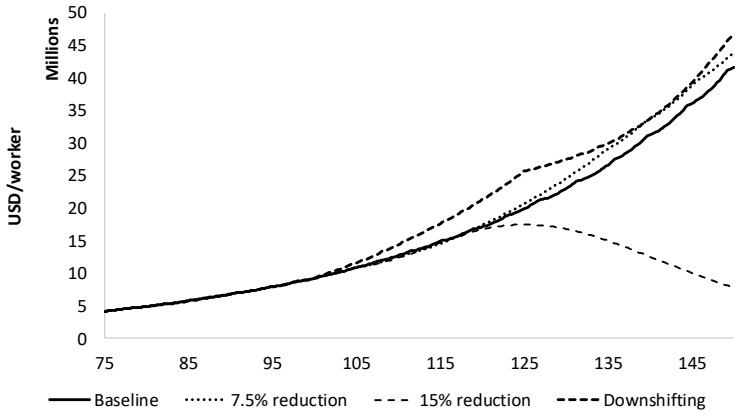

Figure 9: Capital to labor ratio

6 Discussion and conclusion

In an economy out of equilibrium, the sequence of events matters. In an equilibrium model, reduced consumption and reduced wage income happen together, whereas in a disequilibrium model with delayed feedbacks it takes time for the system to accommodate the change, and actions may not have their intended effects. In the model, reducing consumption without reducing working time either has no net effect – the economy recovers and cycles around the baseline trajectory – or it leads to a worsening contraction. In contrast, if workers reduce their working time, then the economy can slow significantly without collapsing[54].

The model results shed some light on debates in ecological economics around the causes of economic growth. Fractional reserve banking is not a driver of growth in this model[55]; our treatment of business investment is consistent with a "horizontalist" position on money and banking[56], in which the central bank is free to set an interest rate, while commercial banks offer businesses the credit they demand. Furthermore, without a financial sector, financialization is not driving unsustainable growth in the model[57]. Instead, growth is driven by the prospects for business income. When those prospects are rosy, the economy tends to grow, and when they wither, the economy can falter and even slide towards collapse.

A low-carbon transition must involve citizens, their government, the private business sector, and trading partners. The model presented in this paper is of a closed economy without a government sector, and in the scenarios we presumed that only households take the initiative. Despite the limitations of the analysis, the results show that households can effect significant change in the absence of private sector or government action. The results support Schor's[58] contention that reducing work hours can be an effective strategy. Downshifting, even in the fast lane, could contribute to a low-carbon transition.

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[54] A sufficiently large reduction in the labor force does lead to a self-reinforcing contraction in the model, similar to that in the *15% reduction* scenario.

[55] See Fontana and Sawyer, "Full Reserve Banking" for a thorough discussion of this topic.

[56] Lavoie, "Money, Credit and Central Banks in Post-Keynesian Economics."

[57] Which is not to say that financialization is unimportant. See Jerneck, "Financialization Impedes Climate Change Mitigation."

[58] Schor, "Sustainable Consumption and Worktime Reduction."

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