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Market Dynamics: Measuring Impact of Economic Events and Government Programs on Production and Employment

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Market Dynamics: Measuring Impact of Economic Events and Government Programs on Production and Employment

Joshua F. Dayanim

Abstract- The impact of austerity, fiscal and monetary programs has been a subject of numerous studies and findings regarding the effectiveness of such government policies in combating economic downturns by stimulating growth, increasing employment, and promoting investment. The recently introduced Market Dynamics method has been extended to provide a dynamic Production model that incorporates employment, wages, consumption, investment, government spending, interest rate, taxes, and other related factors. The model is used to compare the impact of austerity, fiscal and monetary programs in response to an economic downturn and to measure the size and effectiveness of government actions including changes in spending, taxation and interest rates. A conservation of commerce principal is defined stating that money flow from wages, spending, borrowing and interest activities must match the change in production trades. The latter mechanism is responsible for a lag in response as the full impact of an event is gradually realized over its time horizon. A superposition method is also introduced providing for the measurement of impact from multiple overlapping events. The formulation draws on the classical science of motion thus enabling access to a vast pool of existing scientific knowledge. It also presents new insights into the measurement and analysis of interactions between policy and economic outcome.

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I. Introduction

Several models are widely used to measure the impact of economic events and government responses on production and employment with varying strengths and weaknesses. These include large-scale macroeconomic, vector autoregression (VAR), and dynamic stochastic general equilibrium (DSGE) (Auerbach 2012). Macroeconomic based methods are often difficult to construct and compare since observed data does not point to a single preferred policy (Wielan 2012). In contrast, VAR models utilize systems with multiple variables each defined by its own lagged response values as well as those of other remaining variables. Using an impulse-response approach, future expected values of these variables are calculated in response to a unit increase in a single variable (Sims 1980). Lastly, DSGE models rely on empirical data to calibrate the values of structural components such as demand, supply and government policy, and apply a synthetic series of shocks in order to calculate the corresponding moments and then compare to observed data. The latter also utilizes an impulse-response approach along with stochastic methods in order to calculate the expected outcomes (Ruge-Murcia 2007; Sbordone 2010). These models can vary based on assumptions related to price flexibility and simulated behavior of their structural components.

It seems a more foundational model that incorporates various factors of production and their interactions would be benefitial. Such approach would present a more consistent view of the economy and provide new insight into the relatinships between employment, wages, consumption, spending, investment, and other production factors. The presented extension to Market Dynamics (Dayanim 2011, 2016) provides a differential approach to measuing the impact of economic events and government responses on production output. The formulation introduces a production equation, defines a conservation of commerce principal, and uses an event driven approach to measuring the impact of economic activities. Starting with a basic production equation, the model is enhanced in successive steps to take into account the various factors affecting production. An event time horizon as well as several dynamic indicators are presented that assist in measuring the progress towards the expected change in production. A superposition method is introduced that provides for the addition and measurement of the cumulative impact from multiple consecutive events with overlapping time horizons.

The model is applied to a comparative analysis and measurement of possible government responses to an economic downturn event in the form of austerity, fiscal and monetary porgrams. These programs are based on several prevelant theories regarding the impact of government actions on the economy. Historically, the Keynesians argue that government can fuel growth by borrowing money and returning it into the economy through various spending programs (Kaynes 1936). On the other hand, "Deficit Hawks" believe that budget deficits are at fault as they lead to higher interest

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rates which in turn results in lower investment. Hence, Austerity in the form of increased taxation and reduction in government spending is viewed as the primary means for resolving and averting crisis (Crotty 2011). Finally, Monetary policy aims to promote employment, stable prices, and moderate long term interest rates through actions by the central bank including purchase and sale of government securities, adjustments to the short term discount rate, and changes in bank reserve requirements (Board of Governors of the Federal Reserve System 2016).

The model is used to measure the size of austerity, fiscal and monetary programs in the form of changes in government spending, taxation and interest rate required to restore production and employment to pre-economic downturn levels. Using current economic data, the model is further applied to the analysis of observed slow down in production and money flow growth. By determinig the sources of economic slow down several potential courses of action are identified.

II. Dynamics of Production

a) The Production Equation

The production level for a simplistic isolated economy consisting of individual workers, buyers, and sellers who freely exchange goods and services can be stated as:

$$P_n = C_n + I_n \tag{1}$$

where P_n represents the production level in a specific time period *n*, C_n the value of consumable goods traded during the same period, and I_n the value of traded investments. P_n is also a measure of purchasing power or in this case earned wages and can be measured by multiplying the number of gainfully employed labor force f_n by the average prevelant wage to obtain total wages in the economy, that is:

$$P_n = W_n = f_n . \overline{w_n} \tag{2}$$

with employment level in turn measured as the ratio of employed labor force over the total available labor force seeking employment F_n, or:

$$E_n = \frac{f_n}{F_n} \tag{3}$$

In this context, consumables are goods and services that are used by individuals and provide little residual value past their expected life such as food and cars, while investments represent accumulated capital such as inventory, equipment and buildings. Note that the generation of consumed goods and investments may have occured during any past or present period, and what is relevant is when the value is realized through a trade activity. Hence, any goods or services that are not traded due to lack of interest or inactivity are ignored until discarded or sold in a later period. The value of consumables is determined using a value added approach by measuring the sum of all trades or purchases *p* during the period less the cost of any raw material, equipment or services (excluding wages) used in production *m*, that is:

$$C_n = \sum_i (p_{ni} - m_{ni}) \tag{4}$$

Similarly, investment value or accumulated capital is measured as the sum of individual transactions by adding the difference between the buyer's purchase value and the seller's cost basis for each transaction less the cost of any improvements, that is:

$$I_n = \sum_i (ps_{ni} - pb_{ni} - m_{ni}) \tag{5}$$

where ps is the sale price and pb the original purchase price. In this manner, equation (1) states that in a simple isolated economy earned wages are fully utilized to purchase consumable goods or invest in capital assets. Combining equation (1) and (2) results in:

$$P_n = W_n = C_n + I_n \tag{6}$$

i. *Government Spending*

Basic sources of government spending include taxes *T* collected from earned wages and loans *L* obtained from participants in the economy who are willing to lend funds in return for repayments *R* over an extended period of time at a set interest rate. The government spending can be viewed as additional production capacity that is added to the economy while wage taxes represent a corresponding reduction, that is:

$$P_n = W_n - T_n + G_n = C_n + I_n \tag{7}$$

where wage tax is measured as a product of earned wages and the weighted average tax rate:

$$T_n = W_n . \overline{t_n} \tag{8}$$

and government spending consists of several components:

$$G_n = a_n . T_n + GL_n - GR_n \tag{9}$$

where the tax spending coeficient *a* represents the portion of wage taxes spent back in the economy, *GL* the level of government borrowing in the current period, and *GR* the accumulated loan repayment amount for the period. It is reasonable to set a equal 1 where there is new government borrowing in the period so that all taxes are spent prior to borrowing additional funds. However, the value of a may be less than 1 if taxes are used to pay down loans and lower the repayment amount on past borrowing activities. Government spending in the economy effectively transforms into worker wages hired to perform government sponsored initiatives.

ii. *Exports and Imports*

In the presence of other foreign economies, goods and services may be traded across national

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boundaries. To account for this, consumables can be viewed to consist of domestically produced goods and services consumed within the local economyCD_n, as well as two new elements related to the consumption of exports *CX* and imports *CM*:

$$C_n = CD_n + CX_n - CM_n \quad (10)$$

with the latter stating that production level increases with growing exports and decreases with a rise in imports. Equations (7) and (10) when taken together somewhat resemble the familiar aggregate demand equation:

$$AD = C + I + G + X - M \quad (11)$$

where *X* and *M* indicate exports and imports (Wikipedia 2016).

iii. *Foreign Investment*

Similarly, participants in foreign economies may invest in the local economy and the investment component is adjusted to account for foreign investment activities, that is:

$$I_n = ID_n + IM_n - IX_n \quad (12)$$

with *ID* representing domestic investment by local investors. The level of investment in the local economy increases as foreigners invest in the system *IM* and is lowered as local funds flow outside the system *IX*.

iv. *Personal Savings and Borrowing*

Savings represents excess earned wages lent by participants in the economy to investors in return for received interest income. In this manner, savings lowers the production impact of wages but in turn results in an increase in investment activity as more funds are available for borrowing. Participants in the labor force can also borrow money for investment and pay back over time with interest. The net effect of personal savings and borrowing is as follows:

$$P_n = W_n - T_n + G_n + F_n \quad (13)$$

where

$$F_n = FL_n - FR_n - FS_n + FN_n \quad (14)$$

with *FL* and *FR* representing personal borrowing and loan repayment, and *FS* and *FN* representing personal savings and earned interest. The amount of earned interest depends on the prevailing rate of interest for savings *rfs*, that is:

$$FN_n = \left(1 + \overline{rfs_n}\right).FS_n \quad (15)$$

and similarly the repayment on a personal loan is based on the prevailing loan interest rate *rfl*:

$$FR_n = \left(1 + \overline{rfl_n}\right).FL_n \quad (16)$$

v. *Inflation*

Inflation may be viewed as an increase in the price of consumable goods and services. Equation (4) can be stated using prices from the prior period in order to account for the current period's inflation, as follows:

$$C_n = \sum_i (1 + ri_{ni}).p_{(n-1)i}.q_{ni} \quad (17)$$

$$C_n = \left(1 + \overline{ri_n}\right).\sum_i p_{(n-1)i}.q_{ni} \quad (18)$$

where a weighted average inflation rate$\overline{ri}$ is used to measure consumption amount at the end of the period using prior period prices. If similar quantities of good and services were purchased in both periods, the above can be restated as:

$$C_n = \left(1 + \overline{ri_n}\right).C_{n-1} \quad (19)$$

However, inflation can have a negative impact on consumption due to higher prices unless accompanied by a similar increase in wages.

vi. *Economic Growth*

Economic growth may be a result of an increase in employment or population, a rise in wages or labor productivity, elevated domestic consumption or investment, additional foreign interest in domestic products, or similar factors. This can be stated as:

$$P_n = \left(1 + \overline{rg_n}\right).P_{n-1} \quad (20)$$

where *rg* is the average rate of growth. A moderate economic growth is considered beneficial as it encourages higher average wages and employment, lower government borrowing, and increased investment.

vii. *Behavioral Factors*

Changes to the production level can be attributed to individual events, some tangible such as a change in personal lending rate or additional government spending with others more behavioral such as loss of consumer or investor confidence. The impact of behavioral elements is reflected as changes to the values of *C* and *I*. For example, the trading value of an investment such as a security or rental property may be stated as the product of its current earnings *IE* and price to earnings multipler *IPE*, that is:

$$p_i = IE_i.IPE_i \quad (21)$$

where the value of *IPE* incorporates the behavioral aspect of investors (Dayanim 2011, 2016). The value of *IPE* can be measured historically, for example using a 30 day average for recent transactions, or estimated using other behavioral based models. By applying a partial derivative to an investment the impact of a change in the multiplier on the investment value can be determined using:

$$\Delta p_i = \Delta IE_i.IPE_i + IE_i.\Delta IPE_i \quad (22)$$

The overall number of transactions may also be affected due to a drop in investor demand as uncertainty in the economy rises. A similar approach can be applied to Consumables component of production using equation (4) where transaction price

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and quantity incorporate the relevant consumer behavior. For example, a demand and supply based model can be used to estimate the change in consumable trades in the aftermath of an event.

viii. *Other Production Factors*

Local wage or sales tax, currency exchange rates, depreciation of goods and similar production factors can be introduced into the formulation by adjusting the corresponding component in the Production equation. For example for a wage and consumption sales tax imposed by a locality new terms can be added to equation (13) as follows:

$$P_n = W_n - T_n + G_n + F_n - LT_n + LG_n \quad (23)$$

where *LT* is the local sales tax and *LG* the local government spending. These can in turn be restated as:

$$LT_n = LW_n . lt_n + LC_n . lst_n \quad (24)$$

using local wages *LW*, local consumption *LC,* as well as local wage and sales tax rates *lt* and *lst.* Also,

$$LG_n = la . LT_n + LGL_n - LGR_n \quad (25)$$

using a local tax spend coefficient *la*, local government borrowing *LGL* and loan repayment amount *LGR*.

b) Conservation of Commerce

Equation (6) represents a conservation principal stating that money flow from various sources such as wages, government borrowing and interest earnings equals the added value in traded consumables and investments., that is:

$$MF_n = \Delta P = \Delta(C + I) = C_n + I_n \quad (26)$$

where ΔP represents the change in production capacity in time period *n* or simply P_n and *MF* the money flow. In this manner contributions from successive periods can be added in order to measure the aggregate commerce over time:

$$P(t) = \sum_n MF_n = \sum_n (C_n + I_n) = C + I \quad (27)$$

where *C* and *I* represent the total trade in consumables and investments during the observation time period starting from an initial equilibrium point. The full impact of an economic event is realized over an event's *Time Horizon* as money flow from various trade activities accumulates to fully account for the anticipated change in production.

c) Dynamic Indicators

Several movement indicators are defined that provide for the measurement of progress towards a target production level for an event. As an event's time horizon nears, the accumulated money flow from trading activities fully supports the anticipated change in production and a new stable production level is formed. An event's *Support Level* may be measured by dividing the accumulated money flow from trades at time *t* by the anticipated change in production:

$$ESL(t) = \frac{MF(t)}{\Delta P} \quad (28)$$

where $\Delta P = P_T - P_0$ with P_0 representing the initial production level at the event's onset. The target production level P_T is measured using equation (7) after adjusting for changes in the various production factors. The event's *Time Horizon* can be estimated using:

$$ETH = \frac{t}{ESL(t)} \quad (29)$$

assuming a linear progression in time. The support level reaches 1 once the event's time horizon is reached. The expected production level P_E incorporates changes attributed to the accumulated money flow at time *t* and is estimated using:

$$P_E(t) = P_0 + \Delta P . ESL(t) \quad (30)$$

A *divergence* indicator is defined to measure the difference between the target and current observed production levels:

$$ED(t) = \frac{P_T - P(t)}{P(t)} = \frac{\Delta P_T}{P} \quad (31)$$

while a similar *expectance* indicator measures the difference between the expected and current observed production levels:

$$EE(t) = \frac{P_E(t) - P(t)}{P(t)} = \frac{\Delta P_E}{P} \quad (32)$$

d) Superposition of Events

Using the presented dynamic model, the aggregate impact of events such as economic shifts and government actions on the production level can be measured by superposing multiple events and adding their individual impact on production. This is possible since the formulation in equation (6) presents a linear system. This process is particularly important as the full impact of an event often lags behind its initial onset. The effect on the economy and production is seldom immediate since it requires time for participants and governments to digest and analyze an event, adjust their consumption level, borrow funds, find investment opportunities, or lower tax rate and interest on loans. An event *Time Horizon* can be defined representing the elapsed time from the onset of an event until its impact is fully realized. In this manner, one often observes the aggregate impact of multiple events with overlapping time horizons when measuring various economic indicators.

To demonstrate this, Table 1 lists the federal reserve monetary policy actions from 2006 through 2015. This data is used along with first mortgage originations in Table 2 to estimate the change in borrowing level and repayment amounts and calculate the impact on money flow and production for this one

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factor. To do so, the expected ΔFR, that is the anticipated change in consumer debt repayment for each federal funds rate change event is measured by considering that the total outstanding mortgage debt as of the event's onset will be refinanced over time at the lower rate. To demonstrate the point a quick estimation of the expected change in repayments is made by multiplying the total mortgage debt by the rate change as though the debt consists of equity line mortgages. Alternative estimation methods can prove more accurate by using the average mortgage balance, financing rate, remaing term and monthly payments. Finally, the expected loan repayment also includes adjustments related to shifts in the aggregate borrowing level *FL* which is measured using a product of the incremental change in borrowing and the current interest rate.

As the impact of a rate change is realized gradually over time the event's time horizon can be estimated by dividing the number of outstanding mortgages by the mortgage origination volume for the quarter. For example for the 2008Q1 rate change event, the estimated time horizon is 25.4 quarters or 6.3 years. The event's incremental ΔFR contribution for each pursuing quarter can also be estimated by multiplying the total expected change in debt repayment at the event's onset by the ratio of quarterly mortgage originations to the total outstanding mortgages in 2008Q1. This iterative process ends once the aggregate quarterly mortgage originations reaches the total oustanding mortgages at the event's onset indicating a full portfolio turn-over. The latter discussion assumes the average mortgage loan value remains relatively unchanged during the event's time horizon, but a more accurate treatment would utilize the aggregate mortgage values rather the counts. Table 3 details the impact over time for three successive rate change events starting with 2008Q1 and the results are displayed in Figure 1. Each dotted or dashed line depicts the lagging behavior attributed to a specific event with the solid line showing the aggregate impact.

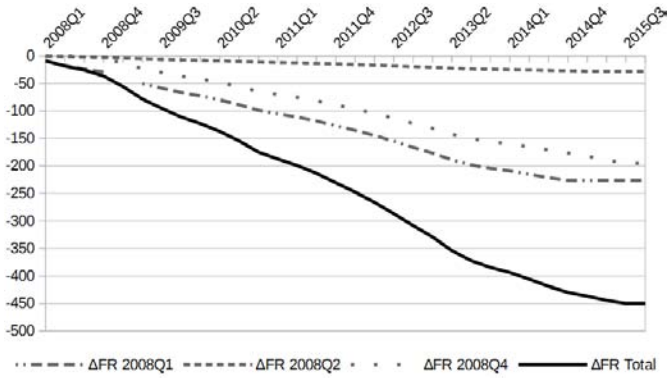

Fig.1: Expected change in mortgage repayments ($B)

III. Government Programs

a) Economic Downturn Scenario

Equipped with a dynamic model of production and its various factors, it is now possible to evaluate the impact of discrete events and analyze how a specific government response may affect the economy. Consider a scenario where an event results in a drop in demand and the right side of the production equation (1) suddenly shifts downward. Since the government is interested in avoiding an economic downturn, there is an interest in determining how to maintain the starting employment level and wages prior to the onset of the event. Three popular programs are analyzed include austerity, fiscal and monetary policies.

b) Austerity

Policy makers believe that the economy is over-leveraged due to excess borrowing and the path to recovery is to pay down debt by raising taxes and cutting government spending on social programs. The policy objective is to maintain the starting employment level and wages despite a recent decline in the right side of the production equation, that is a drop in consumption and investment. In this scenario, additional taxes need to be raised along with a cut in spending in order to push down the borrowing level. Using equations (7) and (9), assuming no additional borrowing during the period and by requiring the government to divert a portion of tax revenues to paying down accumulated debt, yields the following:

$$P_n = W_n - T_n + a_n.T_n - GR_n \quad (32)$$

$$P_n = W_n - (1-a).T_n - GR_n = C_n + I_n \quad (33)$$

For simplicity, assume that the borrowing rate remains unchanged at $\overline{rl_0}$ over the covered time period. The total government loan debt at the beginning of the period is represented by GLT_{n-1} and is lowered by the portion of taxes not spent back in the economy. The revised repayment amount can be calculated as:

$$GR_n = \overline{rl_0}.(GLT_{n-1} - (1-a_n).T_n) \quad (34)$$

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$$GR_n = GR_{n-1} - \overline{rl_0}.(1-a).T_n \quad (35)$$

and the required change in repayment amount in order to achieve wage and employment stability can be stated as:

$$\Delta GR_n = -\overline{rl_0}.(1-a_n).T_n \quad (36)$$

The change in the production equation (33) due to downturn is measured using:

$$\Delta P_n = \Delta C_n + \Delta I_n = 0 - (1-a).\Delta T_n - \Delta GR_n \quad (37)$$

$$= -(1-a).\left(\Delta T_n - \overline{rl_0}.T_n\right) \quad (38)$$

$$= -(1-a).\left(\Delta T_n - \overline{rl_0}.(T_{n-1} + \Delta T_n)\right) \quad (39)$$

and the required incremental tax to achieve stable employment and wages is:

$$\Delta T_n = \frac{-(\Delta C_n + \Delta I_n)}{(1-a).(1-\overline{rl_0})} + \overline{rl_0}.T_{n-1} \quad (40)$$

As an example, if production drops by 10% of wages, loan interest rate is at 4%, starting tax rate is 25%, and 65% of taxes are used to pay down debt, the additional austerity related tax can be calculated as:

$$\Delta T_n = \frac{0.1W_0}{(1-0.35).(1-0.04)} + 0.04.0.25W_0 \quad (41)$$

$$\Delta T_n = 0.16W_0 + 0.01W_0 = 0.17W_0 \quad (42)$$

effectively requiring a 17% increase in tax rate to 42%. Government spending is also reduced from 25% of wages to 15% (35% of the new 42% tax rate) less any borrowed amount during the prior period.

i. *Effects of Austerity*

For an austerity program to restore the economic production to its prior level, it likely requires a substantial increase in wage taxes as well a material reduction in government spending. The size of the program is dependent upon the level of reduction in production capacity. The increase in wage tax rate can deter people from consuming or investing due to shrinking after-tax net wages, and the higher the increase the more severe the impact. This in turn places further pressure on the job market as employers become reluctant to hire due to a drop in consumption. Lowering government spending can further raise the cost of living due to lost entitlements and places at risk certain populations that rely on social benefits. However, a moderate tax rate adjustment coupled with a more judicious spending on social benefits can prove to be a valuable tool in lowering the national debt repayments, reducing risk of default on loans, and restoring economic health.

c) Fiscal Policy

Fiscal policy relies on additional government borrowing and spending in order to stimulate the economy and in this case maintain a neutral wage and employment level in response to an economic downturn. Using equations (7) and (9) several assumptions are made related to an increase in borrowing, stable wage tax rate and employment, and fully spending wage taxes back into the economy, that is:

$$\Delta GL_n > 0; \Delta t = 0; a = 1; \quad (43)$$

then the change in production can be restated as:

$$\Delta P_n = \Delta GL_n - \Delta GR_n = \Delta C_n + \Delta I_n \quad (44)$$

where

$$\Delta GR_n = \overline{rl_0}.GL_n \quad (45)$$

leading to

$$\Delta P_n = \Delta GL_n - \overline{rl_0}.GL_n = \Delta C_n + \Delta I_n \quad (46)$$

and using $GL_n = GL_{n-1} + \Delta GL_n$ the incremental borrowing can be calculated as follows:

$$\Delta GL_n.\left(1 - \overline{rl_0}\right) - \overline{rl_0}.GL_{n-1} = \Delta C_n + \Delta I_n \quad (47)$$

$$\Delta GL_n = \frac{\Delta C_n + \Delta I_n + \overline{rl_0}.GL_{n-1}}{1-\overline{rl_0}} \quad (48)$$

For the prior example, if production drops by 10% of wages, loan interest rate is at 4% and assuming no government borrowing for the prior period, in order to raise the production to its former level the additional fiscal policy related borrowing and the associated repayment cost can be calculated as:

$$\Delta GL_n = \frac{0.1W_0}{(1-0.04)} = 0.104W_0 \quad (49)$$

$$\Delta GR_n = (0.04).(0.104W_0) = 0.004W_0 \quad (50)$$

indicating that a relatively modest increase in government loan repayments is required in response to the downturn.

i. *Effects of Fiscal Policy*

The increase in the size of government borrowing and loan repayments can lead to rising loan interest rates. These rates are also subject to fluctuations in currency exchange rates if a foreign currency is used as the basis of received loans and repayments. An increase in the cost of borrowing can result in a spiralling down of the economy as investment slows down due to higher cost of financing and loss of investor confidence. However, provided a moderate national debt level and a nominal increase in loan interest rates fiscal policy can prove a powerful tool in combating an economic downturn. The impact of fiscal policy appears to diminish in the presence of prior period borrowing as indicated in Equation (48) due to the added contribution in the numerator which requires coverage through additional borrowing.

Fiscal policy at times is accompanied by a lowering of taxes on the premise that it increases net wages thus consumers feel they have more disposable income and apply it towards purchasing additional

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goods and services. However, as equation (32) indicates where wage taxes are fully returned to the economy through government spending the impact of lower taxes may be more psychological and without a lasting effect during a prolonged downturn. This outcome matches survey findings regarding the 2001 tax rebate stimulus impact (Shapiro 2013). However, such tax cuts may be directed at and benefit certain populations that are at greater risk such as lower income households.

d) Monetary Policy

Loan repayment are sensitive to interest rates set by the national regulator or Fed. By adjusting and lowering the personal loan interest rate the Fed can stimulate investment. Using equation (13) and (14) the change in production can be stated as:

$$\Delta P_n = \Delta FL_n - \Delta FR_n = \Delta C_n + \Delta I_n \quad (51)$$

assuming there is no change to the rate of personal savings or government spending during the observation period. When personal loan rates drop investors can refinance existing debt at lower rates and borrow additional funds while maintaining the same repayment levelFR_0. The increase in personal borrowing is then used for additional investment in the economy. The impact can be calculated using equation (16) as follows:

$$\Delta\overline{rfl_n} < 0; \Delta FR_n = 0; \quad (52)$$

$$\Delta FL_n = FL_n - FL_{n-1} = \frac{FR_0}{\overline{rfl_n}} - \frac{FR_0}{\overline{rfl_{n-1}}} \quad (53)$$

$$\Delta FL_n = \frac{-FR_0.\Delta\overline{rfl_n}}{\overline{rfl_n}.\overline{rfl_{n-1}}} = \frac{-FL_{n-1}.\Delta\overline{rfl_n}}{\overline{rfl_n}} \quad (54)$$

$$\Delta P_n = \frac{-FL_{n-1}.\Delta\overline{rfl_n}}{\overline{rfl_n}} - 0 = \Delta C_n + \Delta I_n \quad (55)$$

$$\Delta\overline{\text{rfl}_n} = \frac{-\overline{\text{rfl}_n}.(\Delta C_n + \Delta I_n)}{FL_{n-1}} \quad (56)$$

For the prior example, if production level is dropped by 10% of wages with personal loan rate of 6%, given that the prior period personal borrowing is at 20% of wages, the required change in pesonal interest rate to maintain a stable wage and employment level is:

$$\Delta\overline{rfl_n} = \frac{-(0.06+\Delta\overline{rf_n}).(0.1W_0)}{0.2W_0} \quad (57)$$

$$\Delta\overline{rfl_n} = \frac{-(0.06+\Delta\overline{rfl_n})}{2} \quad (58)$$

$$3\Delta\overline{rfl_n} = -0.06 \quad (59)$$

$$\Delta\overline{rfl_n} = -2\% \quad (60)$$

$$\overline{rfl_n} = 6\% - 2\% = 4\% \quad (61)$$

The loan interest rate must be lowered by 2% to reach the stated goal. The new pesonal loan level is:

$$FL_n = FL_{n-1}.\frac{\overline{\text{rfl}_{n-1}}}{\overline{\text{rfl}_n}} = 0.2W_0.\frac{0.06}{0.04} = 0.3W_0 \quad (62)$$

which has increased by the amount of drop in the prior period production level.

i. *Effects of Monetary Policy*

The drop in personal loan rate can result in increased borrowing and consequently a boost in production level provided investors are mainly considered with repayment costs. However, the increased personal debt can pose a problem as loan rates return to normal levels over time resulting in higher repayment costs and an increasing number of defaults on personal debts. This negative impact can be mitigated through the use of fixed rate term loans as well as a more gradual renormalization of rates.

In reality, the effect of monetary policy may be somewhat smaller since aside from line of credit loans most term loans require repayment of a portion of the principle with each payment. For example, for a 30 year loan at 6% interest the annual payment for interest and principle is 7.2% of the initial loan amount payable in monthly installments, whereas at 4% interest the annual payment is 5.7% of the loan amount for a difference of only 1.5%. In order to reach the same level of increase in personal borrowing a larger interest rate drop is required. In the long run, borrowers can benefit from the principal repayment which lowers the loan amount and allows them to borrow additional funds through refinancing.

IV. Economic Growth

Current economic growth can be estimated by incorporating changes in various production factors. The data is Table 4 is used to demonstrate the expected change in production. Combining equations 6, 9, 10 and 14 results in:

$$P_n = C_n + I_n = W_n - T_n + a_n.T_n + GL_n - GR_n + FL_n - FR_n - FS_n + FN_n \quad (63)$$

$$\Delta P_n = \Delta W_n + \Delta GL_n - \Delta GR_n + \Delta FL_n - \Delta FR_n - \Delta FS_n + \Delta FN_n \quad (64)$$

and the incremental annual changes can be measured for the period between 2013 and 2016 assuming $a = 1$ and is presented in Table 5.

The data indicates that the pace of growth in production or money flow is slowing down, specially when measured per employee as shown in Table 6. This is largely attributed to a slower growth in personal income and personal debt which are the largest two contributors to money flow. At the same time, the growth in consumption appears to be tapering down as well. As the trade deficit has remained relatively unchanged, the latter implies a slower rise in domestic production output.

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In order to accelerate production growth, the money flow needs to increase. This can be achieved by additional government spending, a rise in domestic wages due to tighter labor markets or higher foreign labor costs, increased domestic investment by foreign nationals, or increased household borrowing. Specific actions may include new government spending on infrastructure projects, inclusion and enforcement of fair labor practices in trade deals, improvement in international economies leading to higher employment and wages overseas, incentives for investment in domestic plant and manufacturing, and further easing of consumer credit. At the same time, the expected rise in federal funds rate serves as a retardant force. Each possible action requires careful consideration in order to avoid negative side effects such as escalating national debt, trade wars, and household loan defaults.

V. Conclusion

This study presents a dynamic model for the economy that takes into account various factors contributing to the production and trade of consumables and investments. Using a conservation of commerce principle, the formulation shows how flow of money from wages, spending, borrowing, and interest earnings fully accounts for observed trade activities. While economic events result in shifts in production capacity, the full impact of such events often lags behind and is materialized over an event's time horizon as trading activities continue. Once the accumulated commerce matches the observed change in economic production an equilibrium condition is reached representing a stable and fully supported production level.

Starting with a simple production model, the formulation is extended to incorporate key economic factors such as taxes, government spending, personal savings and borrowing, and provides for further extensions and analysis of specific areas of interest. This includes tangible as well as intangible behavioral elements that directly impact the level of consumption and investment in the economy. The latter remains an area that requires further investigation.

As multiple economic events may occur within an observation time period, a superposition method is introduced for adding the impact of individual events over their applicable event time horizons. In this manner, the approach provides for the study of production movements over extended periods of time. The dynamic model may also be used to forecast changes in production based on assumptions related to each contributing factor. Further work is needed in applying the model using historical data for key economic events and government actions and subsequently comparing the calculated outcomes against observed values.

The dynamic model is used to analyze the impact of austerity as well as fiscal and monetary policy during an economic downturn. This relies on a methodical derivation using the introduced production equation and is presented in the form of a comparative study on how each policy can restore the economy to its prior production level. The presented approach can be used to analyze the effectiveness and impact of government policies on the economy as well as the associated risks. Using published data, the model is also used to review the current production capacity and money flow and identify potential sources for observed sluggish growth.

The presented dynamic method provides needed insight and understanding of the mechanisms responsible for changes to the production level. The classical approach enables access to a vast pool of existing scientific knowledge with potential application to the fields of finance, economy and commerce. The approach may be extended to any market with an orderly clearance of trade transactions, where intrinsic price values can be associated with the underlying traded commodities and goods. The valuations should follow a linear price equation that factors in the underlying market and human elements.

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Table 1: Federal Funds Rate Changes 2006-2015

Date	Fund Rate (%)	Funds Rate Change
12/17/2015	0.50	+0.25
12/16/2008	0.25	-0.75
10/29/2008	1.0	-0.50
10/8/2008	1.50	-0.50
4/30/2008	2.00	-0.25
3/18/2008	2.25	-0.75
1/30/2008	3.00	-0.50
1/22/2008	3.50	-0.75
12/11/2007	4.25	-0.25
10/31/2007	4.50	-0.25
9/18/2007	4.75	-0.50
6/29/2006	5.25	+0.25
5/10/2006	5.00	+0.25
3/28/2006	4.75	+0.25
1/31/2006	4.50	+0.25
1/1/2006	4.25	0
Source:	Federal Reserve Bank of New York	Board of Governers of the Federal Reserve System

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Table 2: First Mortgage Origination Data 2006-2016

Date	Total Mortgage Debt – Single Family ($T)	First Mortgages Outstanding (M)	First Mortgage Origination	Avergae Loan Balance ($)	First Mortgage Origination ($B)	ΔFL Total Mortgages ($B)	rfl	Δrfl (%)	ΔFR Expected ($B)	ΔP Expected ($B)
2006Q1	9.75					0	4.75	0.50	48.750	-48.750
2006Q2	10.08					330	5.25	0.50	67.725	262.275
2006Q3	10.34					260	5.25	0	13.650	246.350
2006Q4	10.50					160	5.25	0	8.400	151.600
2007Q1	10.73					230	5.25	0	12.075	217.925
2007Q2	10.94					210	5.25	0	11.025	198.975
2007Q3	11.13					190	4.75	-0.50	-46.625	236.625
2007Q4	11.24					110	4.25	-0.50	-51.525	161.525
2008Q1	11.32	56.29	2,219,390	144,930	322	80	2.25	-2.00	-224.600	304.600
2008Q2	11.30	56.56	2,127,172	142,620	303	-20	2.00	-0.25	-28.650	8.650
2008Q3	11.26	56.26	1,604,608	138,288	222	-40	2.00	0	-0.800	-39.200
2008Q4	11.15	56.16	1,372,698	138,264	190	-110	0.25	-1.75	-195.400	85.400
2009Q1	11.14	55.46	2,380,585	151,572	361	-10	0.25	0	-0.025	-9.975
2009Q2	11.09	55.17	2,845,034	149,173	424	-50	0.25	0	-0.125	-49.875
2009Q3	11.00	54.57	2,066,527	138,735	287	-90	0.25	0	-0.225	-89.775
2009Q4	10.94	54.39	1,987,193	139,469	277	-60	0.25	0	-0.150	-59.850
2010Q1	10.80	54.42	1,507,370	137,346	207	-140	0.25	0	-0.350	-139.650
2010Q2	10.73	53.74	1,793,454	136,271	244	-70	0.25	0	-0.175	-69.825
2010Q3	10.65	52.99	2,160,284	149,107	322	-80	0.25	0	-0.200	-79.800
2010Q4	10.45	52.24	2,498,105	153,809	384	-200	0.25	0	-0.500	-199.500
2011Q1	10.39	52.64	1,589,669	143,911	229	-60	0.25	0	-0.150	-59.850
2011Q2	10.32	52.58	1,477,656	137,236	203	-70	0.25	0	-0.175	-69.825
2011Q3	10.26	52.14	1,790,007	140,288	251	-60	0.25	0	-0.150	-59.850
2011Q4	10.21	51.56	2,159,959	146,944	317	-50	0.25	0	-0.125	-49.875
2012Q1	10.14	51.28	2,104,254	149,485	315	-70	0.25	0	-0.175	-69.825
2012Q2	10.08	51.11	2,309,196	148,980	344	-60	0.25	0	-0.150	-59.850
2012Q3	10.03	50.59	2,594,017	152,773	396	-50	0.25	0	-0.125	-49.875
2012Q4	9.98	50.48	2,724,464	154,728	422	-50	0.25	0	-0.125	-49.875
2013Q1	9.92	49.79	2,569,939	153,153	394	-60	0.25	0	-0.150	-59.850
2013Q2	9.89	48.75	3,076,005	145,819	449	-30	0.25	0	-0.075	-29.925
2013Q3	9.90	49.22	2,301,341	156,637	360	10	0.25	0	0.025	9.975
2013Q4	9.88	49.87	1,548,731	147,859	229	-20	0.25	0	-0.050	-19.950
2014Q1	9.86	50.22	1,152,554	145,952	168	-20	0.25	0	-0.050	-19.950
2014Q2	9.85	49.90	1,518,593	149,574	227	-10	0.25	0	-0.025	-9.975
2014Q3	9.87	49.81	1,620,548	154,137	250	20	0.25	0	0.050	19.950
2014Q4	9.88	50.02	1,568,467	157,307	247	10	0.25	0	0.025	9.975
2015Q1	9.85	49.90	1,685,587	165,751	279	-30	0.25	0	-0.075	-29.925
2015Q2	9.90	49.48	2,102,167	168,619	354	50	0.25	0	0.125	49.875
2015Q3	9.95	49.94	1,952,662	166,930	326	50	0.25	0	0.125	49.875
2015Q4	9.97	49.73	1,689,754	168,624	285	20	0.50	0.25	25.025	-5.025
Source:	Board of Governers of the Federal Reserve System	Equifax Consumer Credit Trends Report	Equifax Consumer Credit Trends	Equifax Consumer Credit Trends	Mortgage Origination . Loan Balance	ΔTotal Mortgage Debt	Funds Rate	Funds Rate Change	Total Mortgage Debt . Δrfl + ΔFL . rfl	ΔFL - ΔFR

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Table 3: Change in Loan Repayment for Multiple Events

Date	Total Mortgage Debt – Single Family ($T)	First Mortgages Outstanding (M)	First Mortgage Origination	First Mortgage Origination ($B)	Δrfl (%)	ΔFR Target Single Event ($B)	ΔFR Expected 2008Q1 Event ($B)	ΔFR Expected 2008Q2 Event ($B)	ΔFR Expected 2008Q4 Event ($B)	ΔFR Expected Multi-Event ($B)
2008Q1	11.32	56.29	2,219,390	322	-2.00	-226.4	-8.926			-8.93
2008Q2	11.30	56.56	2,127,172	303	-0.25	-28.25	-8.556	-1.062		-9.62
2008Q3	11.26	56.26	1,604,608	222	0		-6.454	-0.801		-7.26
2008Q4	11.15	56.16	1,372,698	190	-1.75	-195.13	-5.521	-0.686	-4.769	-10.98
2009Q1	11.14	55.46	2,380,585	361	0		-9.575	-1.189	-8.271	-19.04
2009Q2	11.09	55.17	2,845,034	424	0		-11.443	-1.421	-9.885	-22.75
2009Q3	11.00	54.57	2,066,527	287	0		-8.312	-1.032	-7.180	-16.52
2009Q4	10.94	54.39	1,987,193	277	0		-7.993	-0.993	-6.905	-15.89
2010Q1	10.80	54.42	1,507,370	207	0		-6.063	-0.753	-5.237	-12.05
2010Q2	10.73	53.74	1,793,454	244	0		-7.213	-0.896	-6.231	-14.34
2010Q3	10.65	52.99	2,160,284	322	0		-8.689	-1.079	-7.506	-17.27
2010Q4	10.45	52.24	2,498,105	384	0		-10.047	-1.248	-8.680	-19.98
2011Q1	10.39	52.64	1,589,669	229	0		-6.394	-0.794	-5.523	-12.71
2011Q2	10.32	52.58	1,477,656	203	0		-5.943	-0.738	-5.134	-11.82
2011Q3	10.26	52.14	1,790,007	251	0		-7.199	-0.894	-6.219	-14.31
2011Q4	10.21	51.56	2,159,959	317	0		-8.687	-1.079	-7.505	-17.27
2012Q1	10.14	51.28	2,104,254	315	0		-8.463	-1.051	-7.311	-16.83
2012Q2	10.08	51.11	2,309,196	344	0		-9.288	-1.153	-8.023	-18.46
2012Q3	10.03	50.59	2,594,017	396	0		-10.433	-1.296	-9.013	-20.74
2012Q4	9.98	50.48	2,724,464	422	0		-10.958	-1.361	-9.466	-21.79
2013Q1	9.92	49.79	2,569,939	394	0		-10.336	-1.284	-8.929	-20.55
2013Q2	9.89	48.75	3,076,005	449	0		-12.372	-1.536	-10.688	-24.6
2013Q3	9.90	49.22	2,301,341	360	0		-9.256	-1.149	-7.996	-18.4
2013Q4	9.88	49.87	1,548,731	229	0		-6.229	-0.774	-5.381	-12.38
2014Q1	9.86	50.22	1,152,554	168	0		-4.636	-0.576	-4.005	-9.22
2014Q2	9.85	49.90	1,518,593	227	0		-6.108	-0.758	-5.276	-12.14
2014Q3	9.87	49.81	1,620,548	250	0		-6.518	-0.809	-5.631	-12.96
2014Q4	9.88	50.02	1,568,467	247	0		-4.789	-0.783	-5.450	-11.02
2015Q1	9.85	49.90	1,685,587	279	0			-0.842	-5.857	-6.7
2015Q2	9.90	49.48	2,102,167	354	0			-0.213	-7.304	-7.52
2015Q3	9.95	49.94	1,952,662	326	0				-5.752	-5.75
2015Q4	9.97	49.73	1,689,754	285	0					
Total						-449.78	-226.4	-28.25	-195.13	-449.78

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Table 4: Annual Data for US Production Factors

Year	Government Spending ($T)	Budget Deficit ($B)	Government Interest Payments ($B)	Employment Non-Farm (M)	Real Personal Consumption ($T)	Trade Deficit ($M)
2013	3.24	15.5	416	138	10.682	-462
2014	3.23	15.8	430	140	11.059	-490
2015	3.36	16.2	402	143	11.352	-500
2016 est	3.95	16.5	433	146	11.560	-496
Source	InsideGov	InsideGov	Treasury Direct	Bureau of Labor Statistics	Bureau of Economic Analysis	US Census Bureau
	G	GL	GR	E	C*	CX-CM*

Year	Household Debt ($T)	Household Debt Service Payment (% Dispoable Income)	Disposable Personal Income ($T)	Household Debt Service ($T)	Personal Savings ($B)	Personal Income ($T)
2013	11.52	10.14	12.576	1.275	620	14.294
2014	11.83	9.90	13.289	1.316	726	15.138
2015	12.12	9.96	13.771	1.370	784	15.738
2016 est	12.37	10.00	14.200	1.420	809	16.180
Source	Federal Reserve Bank of New York	The Federal Reserve Board	Bureau of Economic Analysis	(derived value)	Bureau of Economic Analysis	Bureau of Economic analysis
	FL	FR/DI	DI	FR	FS	W + FN

Table 5: Change in US Production Factors

Year	ΔW+ΔFN ($B)	ΔGL ($B)	ΔGR ($B)	ΔFL ($B)	ΔFR ($B)	ΔFS ($B)	ΔP ($B)	ΔC* ($B)
2014	844	0.3	14	310	41	106	993	477
2015	600	0.4	-28	290	54	58	806	293
2016 est	442	0.3	31	250	50	25	586	208

**Estimated values due to included cost of raw material*

Table 6: US Production Trend

Year	P ($T)	P/E ($K)
2013	23.5185	170.4
2014	24.5118	175.1
2015	25.3182	177.1
2016 est	25.9045	177.4

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