Measurement of Economic Power: An Engineering Approach

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Business Directory¹ defines economic power as “conditions of having sufficient productive resources at command that give the capacity to make and enforce economic decisions, such as allocation of resources and apportioning of goods and services”. This qualitative definition may be sufficient for general discussions, but it does not offer any quantitative measurements for management and control. Is there a way to measure economic power for analysis and synthesis of economic systems in this 21st century? This paper answers this question by introducing a set of quantitative terms from the field of electrical engineering, used in power measurement and control of electrical systems. Circuit theory concepts are introduced to show how the relationship between cash and cash flow in finance is analogous to that of electric charge and electric current and how education level, as economic potential, is analogous to electrical potential that causes current to flow in a circuit. An individual is identified as the basic cash flow source in the economy. Circuit models for an individual as well as a typical production facility are developed and demonstrated with an example. Equations for the measurement of economic power, losses, efficiency, and power factor are presented. It is shown that the individuals are the basic cash flow sources and producers of economic power.

Keywords: economic power, economic potential, economic efficiency

Introduction

Throughout the history, we humans have been experimenting with socio-economic systems that would satisfy life-long needs of most of the people most of the time, but with marginal success. As individuals, we depend upon the time and effort of thousands of others in the society to satisfy our needs for the development and sustenance of healthy bodies, minds, and souls. On the other hand, thousands of others in the society depend upon our time and effort to satisfy these needs of theirs. The barter systems of the long past have been replaced with monetary systems to facilitate market transactions through which these needs are mutually satisfied within the socio-economic infrastructure. Henry Ford and George Westinghouse were the champions of “Classic Capitalism” of early 20th century and were mainly responsible for the Industrial Revolution through the auto and electricity industries respectively. According to Steven Watts (2005):

Fundamentally, Ford believed that high wages helped business in the long run by enhancing worker’s ability to consume. In later years, he insisted: “the real progress of our company dates from 1914”, because with the wage increase “we increased the buying power of our own people, and they increased the buying power of other people, and so on and on. It is this thought of enlarging buying power by paying high wages and selling at low prices which is behind the prosperity of this country”.

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¹ Retrieved from <http://www.businessdictionary.com/definition/economic-power.html>.

Around the same time period, George Westinghouse (as cited in Jonnes, 2003) stated:

My ambition is to give as many persons as possible an opportunity to earn money by their own effort, and this has been the reason why I have tried to build up corporations which are large employers of labor, and to pay living wages, larger even than other manufacturers pay, or than the open labor market necessitates.

Basic economic theory that “employees are assets” combined with “social responsibility” in decision-making, created a well-educated and hard-working middle-class, envy of the world, in USA during most of the last century. However, over the last few decades, “neo-capitalism”, based on the economic theory that wealth of the few creates jobs for many, has destroyed millions of middle-class families as the wealth has accumulated at the top 0.1% (Reich, 2015). With stock markets turned into hi-tech gambling casinos by investment bankers and hedge fund managers, the stock prices of firms, like prices of art collections, are no longer measure of their economic power.

Business Directory² defines economic power as “conditions of having sufficient productive resources at command that give the capacity to make and enforce economic decisions, such as allocation of resources and apportioning of goods and services”. While this qualitative definition may be sufficient for general discussions, it does not offer any quantitative measurements for management and control. So, quantitative terms such as GDP, stock market values of business enterprises, employment levels, international trade balances, etc. have been used for comparative evaluations of global economies (Dernburg & McDougall, 1968). Even the measure of GDP has become questionable with respect to accounting for unpaid workers such as housewives and negative effects of production on environment and depletion of natural resources, as Marilyn Waring (2012) described it:

Even before the revision to the GDP’s “boundary of production” in 1993, the pressure was on from feminist activists around a measure that was used internationally to determine “well-being”. This boundary of production is the rule that excludes - both in theory and in practice - the unpaid reproductive, productive and service work of the environment, and the unpaid work of women and men and girls and boys from being counted in the GDP.

Though the concept of economic power is not the same as presented in this paper, Hessler (2014) has attempted to describe the influence of technology on economic power, which readers may find interesting.

Is there a better way to measure economic power for analysis and synthesis of economic systems in this 21st century? This paper answers this question by introducing a set of quantitative terms from the field of electrical engineering used in power measurement and control of electrical and other physical systems.

Electrical circuit theory concepts (Rizzoni, 2009) are introduced to show how the relationship between cash and cash flow in finance is analogous to that of electric charge and electric current. Using this analogy, measurements associated with several two-terminal elements are defined for economic systems. An individual is identified as the basic cash flow source in the economy. Circuit models for an individual as well as a typical production facility are developed and demonstrated with an example. Certain functions in the economy, such as liability litigations, wars against criminals, etc., are defined as financial burdens analogous to resistors in electric circuits. Equations for the measurement of economic power, losses, efficiency and power factor are then presented. Contrary to the prevailing concept that wealth of the few creates jobs for many, it is shown that the individuals are the basic cash flow sources and producers of wealth in the economy, and that the efforts of many create wealth for the few. A focus on measurement of economic power, and where it comes from, addresses the issue of disappearing middle class around the world. It is shown that the real economic power of a firm is directly

² Retrieved from <http://www.businessdictionary.com/definition/economic-power.html>.

dependent upon those who produce the goods and services delivered by the firm, and not by those who only supply capital or manage resources. It is further shown that certain cash flows for insurances, taxes, legal services, and pension plan activities are treated as “reactive flows” similar to the reactive current flows in electrical machines needed for air-gap magnetic flux. They are necessary for the conversion of employee efforts into economic power output but do not directly contribute to it. Computation of power factor is demonstrated through an example case.

Electrical Engineering Concepts

Circuit theory in the field of electrical engineering has led to a generalized network approach for modeling physical systems. Fundamental variables pertaining to electrical networks and key concepts from electrical circuit theory are first introduced.

The fundamental element in electrical systems is the electric charge, most often represented by the symbol q . The electric charge can be positive or negative. At the atomic structure level, the electrons in an atom are negatively charged with an equal and opposite charge of the proton, making the atom an electrically neutral element. Independent positive or negative charges can exist either as point charges or as distributed line, surface or volume charges in one, two, or three-dimensional spaces respectively. We all are very familiar with static electricity from carpets and other surfaces, due to these charges, in our daily lives. Every electric charge is said to produce an electric field, which exerts mechanical force on other charges placed in it. Movement of a charge in an established electric field due to another charge requires counter force. The work done by this counter force in moving the charge in an electric field is defined as the electric potential or voltage. The rate of flow of charges, such as electrons in a conducting wire, constitutes the electric current.

Problems in electrical systems are classified into two major groups. Electrostatic and electromagnetic field theories are applied to solve problems at the microscopic level. On the other hand, electric circuit theory principles are applied to solve problems at the macro level. For analyzing economic-financial systems at the macro level, concepts analogous to the circuit theory and control systems are considered to be much more valid than the field theory concepts.

In electrical circuits and networks, we categorize circuit components into two groups. One is classified as a group of two-terminal elements and the other as a group of multi-terminal elements. The multi-terminal elements, however, are often modeled by the so-called “equivalent circuits” of two-terminal elements and integrated into the system’s network model. So let us begin our review of electrical circuit theory with two-terminal elements.

Two types of measurements (variables) exist for a simple two-terminal element. One is “Across” the element and the other “Through” the element as shown in Figure 1. The “Across” measurement is the potential or voltage across the two terminals of the element in electrical circuits. The “Through” measurement is the flow of current through the element. The voltage measurement is expressed in volts (in honor of Volta who discovered the electrochemical cell). Quantitatively, it can range from micro-volts [for a 10^{-6} factor] to kilo volts [for a 10^3 factor] depending upon the energy levels in the circuit. The current measurement is quantitatively expressed in Amperes (in honor of physicist Ampère who introduced the law of electromagnetic force between two current carrying conductors). Quantitatively, it can range from Pico amps (for a 10^{-12} factor) to kilo-amps (for a 10^3 factor) depending upon the energy levels of the circuit. The power absorbed or delivered by a two-terminal element is the product of these two variables.

Figure 1. Measurements in two-terminal elements.

These two variables for various physical systems are listed in Table 1 below.

Table 1

Power Measurement Using Through and Across Variables

Systems	Through	Across	Power
Electrical systems	Current I	Potential V	$P = V.I$
Mechanical systems	Force F	Speed N	$P = N.F$
Rotational systems	Torque τ	Speed ω	$P = \omega.\tau$
Hydraulic systems	Liquid Flow Q	Pressure p	$P = p.Q$
Thermal systems	Heat Flow H	Temperature θ	$P = \theta.H$

The simplest and most common two-terminal element in electrical circuits is a resistor (R). The current flow I through the resistor is proportional to the potential V across it, as defined by Ohm's Law. The resistance absorbs the electrical energy and dissipates it as heat. The flow of current through resistors contributes to the loss of electrical energy in the circuit. On the other hand, this property is applied in useful products like incandescent light bulbs, electric ovens, clothes dryers, coffee makers, baseboard heating, etc..

Work, Energy, Power, and Efficiency

Work done in physical systems is measured in joule (J). The basic unit of one joule is the amount of work done by a force of 1 Newton in moving a body through a distance of 1 meter. The capacity of a body or a system to do work is its energy, which is also measured in the same units. However, several other units are also in use for different forms of energy. For example, thermal energy is measured in calories with a calorie defined as the amount of heat required to raise the temperature of one gram of water at 15°C through one degree Celsius (1 calorie equals 4 joules approximately). Another measure of thermal energy is the British thermal unit, abbreviated Btu (1 Btu equals 1,055 Joules approximately).

In static electricity, the work done in moving a unit charge from a point at infinity to the point of measurement is defined as the electrostatic potential at that point. On the other hand, the fundamental unit of energy in electrical circuits is the joule expressed in watt-second (W-s). This being too small a unit, the electrical energy for practical purposes is measured in the well-known units of kilowatt-hours (kWh) we see in our electric bills, where:

$$1 \text{ kWh} = 3.6 \times 10^6 \text{ J (Joules)} \quad (1)$$

Since electrostatic potential V is work done per unit charge, the total work done in moving Q charges is expressed by:

$$W_{ele} = V = \frac{Q}{C} \quad 1 \text{ volt}(V) = 1 \frac{\text{joule}(J)}{\text{coulomb}(C)} \quad (2)$$

where C is defined as the Capacitance of the field, expressed in Coulombs, which is a measure of the strength of electric field.

Power is defined as the time rate at which work is done. That is, it is the time rate of change of energy. Using symbol S_{ele} for electrical energy and W_{ele} for work, the electrical power P_{ele} is expressed by the following mathematical relationships:

$$\text{Power } P_{ele} = \frac{\text{Energy or Work}}{\text{Time}} = \frac{dW_{ele}}{dt} = \frac{dS_{ele}}{dt} \quad (3)$$

From Equation (3), and the fact that the time rate of change of charge Q is electrical current I , we arrive at the well-known relationship for power in electrical systems:

$$P_{ele} = \frac{\text{Work}}{\text{Charge}} \times \frac{\text{Charge}}{\text{Time}} = \text{Voltage} \times \text{Current} \quad (4)$$

Table 1 lists power equations for various physical systems.

On the lighter side, we can see from Equation (3) that: $\text{Time} = \frac{\text{Work}}{\text{Power}}$.

Since time is money, and knowledge is power, we get:

$$\text{Money} = \frac{\text{Work}}{\text{Knowledge}} \quad (5)$$

That is, the lower the level of knowledge for the work being done, the more money one earns, which appears to apply to corporations where salaries get higher and higher as one moves up the management ladder with lower and lower levels of working knowledge.

Therefore, the power absorbed in a resistor R is given by:

$$W_R = V.I \text{ watts} \quad (6)$$

Efficiency in electrical systems is a measure of energy effectiveness of the system. With presence of resistive elements in electrical circuits, some of the input energy is lost as heat dissipation. The total output energy is, therefore, always less than the total input energy. Mathematically, it is expressed as a ratio of the output energy to the input energy:

$$\text{Efficiency } \eta = \frac{\text{Output Energy or Work}}{\text{Input Energy or Work}} = \frac{\text{Output Power}}{\text{Input Power}} = \frac{\text{Output Power}}{\text{Output Power} + \text{Power Losses}} \quad (7)$$

Since electrical energy is expressed in kilowatt-hours and electrical power is expressed in kilowatts, ratio of the output power to the input power is often used as an indicative measurement of efficiency.

Economic System Concepts

Money and cash flow are the fundamental variables representing capital in economic systems, so we define Cash \$ and Cash Flow F as analogous to the Charge q and Current I in electrical systems. Recognizing the fact that the fundamental driver of economic systems is the individual effort, we define educational level of the individual as the economic Potential E analogous to Voltage V in electrical systems. Using the analogy from electrical systems, the economic power of an individual is then:

$$\text{Economic Power } P_s = E \times F \text{ units} \quad (8)$$

where:

$$\text{Cash Flow } F = \frac{d\$}{dt} \text{ dollars / week} \quad (9)$$

Figure 2. Economic power circuit model.

We need to recognize that all economic activity in a society is due to individuals. As depicted in the circuit model above, we define the individual as the “Basic Economic (Cash Flow) Source” of power in the economic systems. To establish the basic unit of economic power, we need to first define the fundamental unit of educational level E of the individual. So, let us define 10 years of formal school education as one unit of “ E ”, completion of high school as 1.2 units, completion of a bachelors degree (16 years of schooling) as 1.6 units, completion of a masters degree or equivalent (18 years) as 1.8 units, completion of a doctorate degree or equivalent (20 years of education) as 2 units. The total cash flow F_T of the basic economic unit consists of three components, as shown in Figure 2. F_S is the cash flow in and out of Savings & Loans accounts. F_G is the cash flow to the governments as taxes. F_C is the consumption component, which contributes to the economic power of the individual. For cash flow F , let us define spending of US\$200/week as one unit (2015 poverty boundary in the US for an individual).

That is, with 10 years of education and \$200/per week cash flow out, and 50 weeks/year, the base unit of economic power is \$100,000 in USA. Let us call it 1 HP (Human Power):

$$1 \text{ HP (Human Power)} = 10(\text{years}) \times (\$200 / \text{week}) \times (50 \text{ weeks} / \text{year}) = \$100,000 \quad (10)$$

Thus, a person with a doctorate degree spending \$1,000 per week will have an economic power of 10 HP ($E \times F = 2 \times \$1,000/\200). This concept can now be extended to express the economic power of a family, by adding total formal schooling of all members multiplied by weekly spending of the family. For example, a family with two members having BS degrees and one child in the fifth grade, and another in the tenth grade, has an economic potential of 4.7 ($2 \times 1.6 + 0.5 + 1.0$) units. If this family spends \$1,500 per week, then the economic power of this family is 35.25 [$4.7 \times (\$1,500/\$200)$] HP. Another family comprising only two members, with one having a doctorate and the other having a masters degree, and spending \$2,000 per week, has an economic potential of 3.8 ($2 + 1.8$) units and power of 38 HP, as follows:

$$E \times F = (2 + 1.8) \times (\$2,000 / \$200) = 38 \text{ HP} \quad (11)$$

We can now extend this concept to an organization such as a business entity. The economic power of this organization is the sum of the economic powers of the individuals working in the organization. The salary paid to the individual employees F_P , and their education level E , are used for calculating the economic power of the firm. Let us now look at some basic elements in economic systems.

Battery

Accumulated savings in the form of assets in the bank and/or collection of rare paintings do not contribute to the actual economic power. Savings in the bank are analogous to the accumulated charge in battery in the electrical system. Just as a battery has an electric potential in the form of stored energy, but has no power until current flows out of it into an external circuit, assets have stored economic energy but no economic power until there is a cash flow out from them into the economy. Just as the rate of discharge of the stored energy in batteries depends on the amperes drawn from it, the rate of discharge of the financial batteries (saving accounts, etc.) depends upon the cash flow paid out of it. The economic power of that asset, of course, depends upon the economic potential (education level) of the individual who owns it, just like the electrical power of a battery depends upon its voltage and the current flow. For example, when X with 10th grade education spends the savings at a rate of \$200/week in 10 days, his economic power is one unit, but when Y with a doctorate degree spends his savings at a rate of \$400/week for the same 10 days, his economic power is four units. That is, economic power belongs to the individual or group of individuals who own the financial assets. Similarly, a multi-million dollar rare painting or an “*objet d’art*”, in a corporate CEO’s office, has no economic power. It is like a financial capacitor or battery with stored cash. It cannot be discharged into the economy until it is sold for cash and then the owner spends it in the market place. It had the economic power for the original artist when it was created and sold for cash and generated the cash flow for the artist. The economic power of that item, and others created by the same artist, was the level of education of the artist multiplied by the cash flow spent from the earnings. In other words, such non-cash assets do not contribute to the economic power of the society, though they may have value and utility to the owners and can be sold to others. Net stored economic energy in a fixed asset can be computed as follows:

$$\text{Stored Energy } W_s = \int E.F.dt = E \int \frac{d\$}{dt}.dt = E.\$(\text{dollar.years}) \text{ units} \quad (12)$$

However, a collection of such assets in museums generating a cash flow out, through employees of the museums, contributes to the economic power.

Burden

Just as batteries and power generators in electrical systems have “source impedance” and contribute to internal power losses, we can define “financial burden” for business enterprises that contribute to economic losses. Functions that do not directly contribute to the output of products and/or services of the firm, such as human resources and legal services, create the “financial burden”. The economic power of the personnel in these functions is treated as an internal economic power loss similar to the source impedance losses in electrical batteries and generators.

We can now define the economic power efficiency of business enterprises by computing the economic power of the employees who contribute to the “direct cost” of the operation and economic power of the personnel who contribute to the “overhead cost” and then by taking the ratio as in Equation (7):

$$\text{Efficiency } \eta = \frac{\text{Output Power}}{\text{Input Power}} = \frac{\text{Active Power}}{(\text{Active Power} + \text{Passive Power})} \quad (13)$$

We can extend this concept to the computation of economic power and efficiency of villages, towns, cities, states, and nations by defining the functions of the people directly involved in building of economic infrastructure and production of industrial and consumer goods as output of the economy. Except for those who

personally benefit from them, everyone else accepts the fact that industries associated with marijuana, alcohol, tobacco, and gambling are counterproductive and do more harm to the economy than do any good. Therefore, the collective economic power of those employed in these industries contributes to the “burden” losses in determining the economic efficiency of a country:

$$\text{National Efficiency } \eta = \frac{\text{Economic Power of People Producing Products and Services}}{\text{Economic Power of Entire Population}} \quad (14)$$

Inductor

In electrical machines that convert electrical power to mechanical power and vice-versa, magnetic fields are produced by windings. Though the current flow to produce these magnetic fields does not directly contribute to the electrical power of the machine, it is still needed. Similarly, there are certain activities, such as insurance, litigation, disaster management, etc., in economic systems that do not directly contribute to the economic power but they do require cash flow. We define them as economic inductors. The cash flow in these activities can be defined as “reactive flow”. For example, in case of a business entity, insurance and taxes are required for the supporting infrastructure, which constitute reactive cash flow. Analogous to power factor defined for electrical machines, we define power factor for engines of economic production:

$$\text{Power Factor} = \frac{\text{Total Cash Flow} - \text{Reactive Cash Flow Expenses}}{\text{Total Cash Flow}} \quad (15)$$

Transformer

Economic power is transferred from one party to another through transfer payments such as government taxes, contributions to not-for-profit charities and political organizations, and insurance premiums. This is similar to transformer action in electrical systems in which electrical power is transferred from one level of voltage and current to another. While the transfer of this power is considered lossless with respect to cash flow for taxes, and most contributions to not-for-profit charities, the insurance premiums are transferred through impedance losses connected with the overhead costs and profits of insurance companies. Since health insurance companies are neither sellers nor buyers of healthcare services, they contribute to economic losses through additional paperwork burden for both producers and consumers, especially in an oligopolistic market structure such as the one in the US. Its counterproductive effects in the US healthcare system are well documented.

Converters

Electrical machines convert electrical power to mechanical power and vice-versa. There are also converters in electrical systems that convert alternating current (AC) power to direct current (DC) power and vice-versa. In factories, software houses, and healthcare facilities, etc., employees receive cash flow from employers and convert it to products and services, and producers convert their products and services into cash flow. So, such facilities can be defined as “converters” for modeling economic systems.

Production Facility Model

Using the circuit elements described above, we build a circuit model of a typical production facility as shown in Figure 3. It is a closed loop system; the sale of products and services constitute the “Cash Flow” F_R source of the facility at the input converter. It takes raw materials and energy to convert these inputs to finished products and services by the production employees at the output converter.

Figure 3. Typical production plant circuit model.

The payment to the suppliers of the raw materials and energy is cash flow out F_{me} through the lossless transformer element. Insurance premiums as well as the interest and dividend payment to the suppliers of capital constitute the cash flow out F_{ID} through another lossless transformer element. All taxes paid to local, state, and federal governments is the cash flow out F_G through another lossless transformer element. The cash flow F_P of the payroll to all the employees flows to the output converter through the impedance element of indirect overhead functions. Accounting and sales functions directly associated with the production belong to the output converter element. The balance cash flow F_S may be positive (as savings) or negative (as loans against line of credit) which is represented by the battery element. The gross economic power of the facility $P_{GEC} = F_R \cdot E_{Ave}$, where E_{Ave} is the average of educational levels of all employees and F_R is total cash flow of revenues. However, since the cash flows out to the providers of materials, energy, capital, insurance, and civil infrastructure, do not directly contribute to the economic power of the employees, the net economic power of the facility $P_{ec} = \sum_{i=1}^{i=n} E_i \cdot F_i$. To determine the power efficiency of the facility, we first compute the power loss in the impedance P_{Loss} by adding up the economic power of each employee (gross monetary compensation multiplied by his/her education level) in the legal and administrative overhead staff functions. Then, we compute the net output power P_{Out} by similarly adding up the economic power of each employee directly responsible for production, distribution, and sale of the output products and services. The plant's economic efficiency is then as given by the following equation:

$$\text{Plant Economic Efficiency } \eta = \frac{\text{Active Economic Power}}{(\text{Active} + \text{Passive})\text{Power}} \quad (16)$$

Example

Let us apply the concepts presented here to a typical office of a solo practice of an ophthalmologist. Besides the physician herself, there is an office manager and seven skilled and unskilled employees, as given in Table 2. Since not everyone is a full-time employee, their salaries do not relate to their education levels.

Table 2

Ophthalmologist's Office Employee Data

Employee	Education	Contribution of effort		Annual pay
		Direct %	Indirect %	
Physician/Surgeon	MD	100	0	\$260,000
Office Manager	BA	0	100	\$40,000
Optician/Technician	HS+0.5 yr.	95	5	\$20,000
Optician/Technician	HS+1	95	5	\$30,000
Assistant technician	HS	100	0	\$20,000
Head technician	Assoc. deg.	95	5	\$35,000
Billing asst./Scheduler	BS	0	100	\$20,000
Scheduling/Billing mgr.	Assoc. deg.	100	0	\$35,000
Clerical associate	HS	5	95	\$20,000
Total				\$480,000

In addition, the cash outflows include the expenditures for materials and utilities of \$78,000; Rent, depreciation, capital exp. of \$57,000; and insurance, taxes, legal services, pension plans of \$65,000, for a total of US\$200,000.

We convert education levels of each of the employees to their “economic potential” based on the scale of 10 years of schooling as one unit, and convert their annual salaries to weekly per unit cash flows with \$200/week as the base unit. Multiplying the economic potential and per unit cash flow for each employee, we compute economic power of each employee. Based on their contribution of efforts to “direct” and “indirect” components towards patient care, we compute “active” and “passive” portions of their economic power, as given in Table 3.

Table 3

Doctor's Office Employee Data

Employee	Economic potential	Economic power		PU cash flow
		Active	Passive	
Physician/Surgeon	2.5	65	0	26.0
Office manager	1.6	0	6.4	4.0
Optician/Technician	1.25	2.375	0.125	2.0
Optician/Technician	1.3	3.705	0.195	3.0
Technician	1.2	2.4	0	2.0
Nurse technician	1.4	4.655	0.245	3.5
Billing asst./Scheduler	1.6	0	3.2	2.0
Scheduling/Billing mgr.	1.4	4.9	0	3.5
Clerical associate	1.2	0.12	2.28	2.0
Total	13.45	83.155	12.445	48

$$\text{Average economic potential } E_{Ave} = \frac{13.45}{9} \cong 1.5; F_R = 48 + 20 = 68; P_{GEC} = 1.5 \times 68 = 102 \text{ HP}$$

$$P_{ec} = \sum_{i=1}^{i=n} E_i \cdot F_i \quad (17)$$

The “economic efficiency” is determined by the ratio of “active power” to total economic power:

$$\eta = \frac{83.155}{83.155 + 12.445} \times 100\% \cong 87\% \quad (18)$$

The “economic power factor” is determined by the ratio of “active cash flow” to total cash flow, as follows:

$$\text{Power Factor} = \frac{\text{Payroll} + \text{Materials \& Energy} + \text{Rent, Depreciation \& Equipment Costs}}{\text{Total Cash Flow Out}}$$

That is:

$$\text{Power Factor} = \frac{480,000 + 78,000 + 57,000}{680,000} = 0.9PU \quad (19)$$

Conclusions

Electrical engineering circuit concepts are introduced to develop an analogous approach to define and measure economic power, efficiency, and power factor. Assets in the form of savings accounts in the banks, bonds, and art collections, etc. have economic charge but no economic power, just like batteries and capacitors have electric charge but no electric power until there is a current flow from them into an external load circuit. Real economic power of a firm is directly dependent upon those who produce the goods and services delivered by the firm, and not by those who only supply capital or manage resources. There are two types of cash flows in business firms: “active” and “passive”. Cash flows in the activities that produce the economic output are “active flows”. The cash flows for insurances, taxes, legal services, and pension plan activities are treated as “reactive flows” similar to the reactive current flows in electrical machines needed for air-gap magnetic flux. They are necessary for the conversion of employee efforts in to economic power output but do not directly contribute to it. Computation of economic power, power factor, and power efficiency is demonstrated through a simple example case:

(1) Borrowing the famous words of Abraham Lincoln, it is shown that all economic powers are: “of the people, by the people and for the people”. Furthermore, it is shown that the value of a firm is not what the hedge fund managers, investment bankers, and day traders buy and sell shares in the stock market for. Firm’s value is its economic power, based on the employees’ skills, educational qualifications, and efforts, which do not fluctuate in time frames of microseconds;

(2) It can be concluded from the theory presented here that, while “ROBOTS” can perform the tasks of humans, only “HUMANS” have the economic power in a society;

(3) It can be concluded that the economic power of those employed in industries associated with production, distribution, and sales of marijuana, tobacco, alcohol, guns, and gambling is counterproductive and should be treated as economic power losses in determining economic efficiency at the national level. They should not even be included in computing GDP of nations;

(4) Unlike GDP, since level of education and cash flow out rather than earnings is used in computation, economic power of unpaid workers and stay-at-home parents is included in the measurement of power;

(5) Contrary to the prevailing concepts, it can be concluded from the analysis presented here that \$10 million dollars distributed to the employees to increase their “minimum wages” would increase the economic power of the firm, and the nation through ripple effects, as compared to a \$10 million dollar painting hanging in a CEO’s office;

(6) Based on the theory presented here, rather than levy any income taxes on business corporations, a small (2.5%) tax on fixed assets of corporations and individuals, and treatment of dividends as regular income of individuals would be more productive for the economy.

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