ISTANBUL BILGI UNIVERSITY
INSTITUTE OF SOCIAL SCIENCES
BANKING AND FINANCE MASTER'S DEGREE PROGRAM

PROTECTING COST OF CLAIMS FROM EXCHANGE RATE SHOCKS IN INSURANCE SECTOR

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ASST. PROF. GENCO FAS

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SİGORTA SEKTÖRÜNDE KASKO
HASAR MALİYETİNİN DÖVİZ KUR ŞOKLARINDAN KORUNMASI

PROTECTING INSURANCE COST OF CLAIMS FROM EXCHANGE RATE
SHOCKS IN INSURANCE SECTOR

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ANAHTAR KELİMELER

1. Sigortacılık
2. Hasar tazminatı
3. Olasılık
3. Enflasyon
5. Enflasyon geçişkenliği

KEY WORDS

1. Insurance
2. Claim
3. Probability
4. Inflation
5. Inflation Pass-through

To my spouse and children,

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ABBREVIATIONS

AIC	: Akaike Information Criteria
CIP	: Covered Interest Rate Parity
DKG	: Exchange rate Pass-Through
ADF	: Augmented Dickey-Fuller Test
EMPPP	: Efficient Markets view of PPP
GARCH	: Generalized Autoregressive Conditional Heteroskedasticity
GDLM	: Generalized Linear Models
GSYİH	: Gross Domestic Product
IBNR	: Realized But Not Reported Loss Reserve
LM	: Lagranges Multiplier
PAM	: Monetary Transmission Mechanism
PP	: Phillips Perron Test
PPP	: Purchasing Power Parity
PRM	: Poisson Regression Model
SEGEM	: Insurance Education Center
SGP	: Purchasing Power Parity
NBRM	: Negative Binomial Model
RBNR	: Reported but not registered Loss Reserve
UIP	: Uncovered Interest Rate Parity

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ABSTRACT

The pass-through effect of sudden changes in exchange rates on domestic prices has been an important field of research since 1980s among academic circles, monetary authorities and market players. The foreign currency exchange rate pass-through effect means that changes in foreign currency exchange rates are determinative on the general level of domestic prices starting from the import financial prices.

The problem in terms of insurance sector is that it is important in terms of burning cost and premium pricing. The sudden and significant fluctuations in exchange rates spoils the claim/premium ratio of insurance companies. This situation also causes to deviations in the amount of policy reserves.

Knowing how quickly and at what rate exchange rate passes through to domestic prices is critical in the insurance company's business model, claim management and premium pricing policy.

The ultimate aim of the study is to present a solution proposal that will reduce the negative effects of the insurance companies on the insurance cost of claims by revealing the "effect profile" of the foreign exchange currency rates.

Basic insurance concepts are processed at the introduction of Chapter 1 as the general theme of methodology to be followed regarding the handling and resolution of the matter is handled within the scope of insurance industry and "auto insurance policies". While the policy "pricing" issue is handled in terms of commercial, basic net (risk) premium mathematics is described. Car claim frequency calculation has been shown through a modeling sample when the issue is passed to the "probability" from "the law of large numbers".

It has been found that the probability density function "Poisson" and "Negative Binomial" from the "Generalized Linear Regression" models are suitable for predicting the car claim frequency of automobile insurance. Thanks to the "additional parameter" of the "negative binomial" function, it has been shown to be one step ahead in the auto accident claim frequency model despite the Poisson distribution-specific "uniform distribution" constraint that results from the fact that "Poisson scattering" accidents involving insurance sector data have an "unspecified

discrete heterogeneity" scattered as "Gama", which makes it impossible to precisely observe the center of data set contentThe probability calculation results based on the damage prediction and the insurance company's past loss claims information are processed in the "chain ladder" method together with the "time and amount" dimension. Therefore, the information "damage amounts" and the "policy reserves" to be issued therefrom are obtained in terms of insurance companies.

When returning to the "pricing" issue from calculation of probabilities, the minimum net risk premium of the policy has been shown within the triangle of insurance sector, probability mathematics, chain ladder method, claim reserve triangle due to "Net (risk) premium = total claim amount/total insurance amount relationship.

In terms of insurance sector, after that how the "claim cost and its reserve" subject to the exchange rate shock is calculated is shown in Chapter 1, the relation between exchange rate dynamics and inflation are examined in the Chapter 2 of the study. The exchange rate is processed in the context of the "purchasing power parity". The inflation process is expressed within the scope of "Fisher Theory" and in the "monetary transmission mechanism". The monetary depreciation is explained through "direct and indirect" channels. Therefore, after the introduction of "inflation pass-through components" of foreign currency exchange rate shocks, the work of mechanism is shown in the mathematical context of "pricing to market" concept.

The pass-through effect from foreign currency to domestic prices in Turket between 2003-2017 are shown through an empirical study in the 3rd Chapter of the Study. It is aimed that the relation between variables through the model to be set up and is determined in the most appropriate way for the real life. In this context, it is aimed to put a mathematical pattern by expressing the relations between and the foreign currency exchange rate and the inflation. Predicting, testing and evaluating the numerical values of the parameters pointing to the relationships between variables is processed. The relations are transformed into "stochastic" (accidental) from "deterministic" (accurate) in the econometric models formed for prediction and tests of coefficients set up connections between variables (EViews). Thus, the "mechanical" functioning of the pass-through of foreign currency exchange rate to inflation is put forward.

In the study, the pass-through effect through the production chain is examined by a similar approach of McCarthy (2000) Thanks to this structure, findings such as how much an exogenous chain of shock is reflected from one stage to another, and how exchange rate shocks affect domestic prices.

The "vector autoregressive model" (VAR) was used for the analysis of time series (unlike the Simultaneous equation system model) in which the internal and external variables are not clearly distinguished in the process of mathematical prediction and the structural model is not restricted.

It has been seen in the literature that in the determination of causality relationship between variables which are non-stationarity and have no cointegration relationship, "vector autoregressive model (VAR)" comes to the forefront but in the revealing of causality relationship between variables which aren't non-stationarity and are cointegrated, "vector error correction model (VECM)" comes to the forefront.

The time series of the variables in this study are "non-stationarity but co-integrated" and the structure of the pass-through effect (coefficients) is different from the VAR based on the VECM model with error correction term". Periodic numerical effects have been shown through "action and "reaction functions" and "variance decomposition".

The "long term cointegration relation (vector)" between the variables is determined by Johansen Cointegration Model over the "number of delays" used in the VAR model.

Coefficient of the independent foreign currency variable in the "short-term" VECM equation with "error term" and this "the power of pass-through" has been put forward.

It has been revelaed that a deviation happened in the short term and the coefficient of error term will reach "long term balance" by exposed to improvement (adjustment) effect at what rate for each term.

When considering numerical results, a 1% shock to the foreign currency exchange is periodically reflected in Core CPI B at high level in the first few months, this reflection effect decreases symmetrically in the following periods and the pass-through effect from 14th day is largely lost. In terms of the process, a 1% shock to the foreign currency exchange is reflected at 16.0% in Core CPI in two months, in the 3rd month this rate reaches up to 37.89%. At 14th month, this effect becomes normal at the levels of 50.3% and gains stability.

A "Method Proposal" can be used to solve the negative effect of foreign currency exchange rate shocks on the average burning cost in the insurance sector is given in the Chapter 4. Here, the effects of "numerical findings" obtained from the methods used in the 3rd Chapter are revealed in numerically and visually by modeling them on "Expected Inflation Index".

Therefore, it is tried to be used practically and dynamically in the pricing process by the finance and actuary departments in the insurance sector. According to this, the change that occurred in inflationary expectations as a result of a foreign currency exchange rate is dynamically digitized and visualized.

Advantages to be provided and added value generally renews the pricing (tariff) of the finance and actuary employees of insurance sector in Turkey on a quarterly or annual basis. In addition to this, foreign currency exchange rate estimates and "forward exchange rates" are used to reflect the effect of the foreign currency exchange rates on the future.

The fluctuation arising from foreign currency exchange rates shock in the waiting of inflation in the year changes "continously" the general level of prices dynamically together with the interests. The use of forward currencies used as an estimation remains methodologically incomplete.

Since the insurance service is a product whose production happens after its sale, contrary to the commercial goods, it is important to predict what the general level of prices will be in the "future" for "today's premium pricing".

For this reason, the study methods described in Chapter 4 and reflecting the effect of price shocks of foreign currency exchange rate shocks on net (risk) premium pricing over the numbers derived from "econometric" models will produce more healthy and realistic results.

ÖZET

Döviz kurlarındaki ani değişimlerin yurtiçi fiyatlara geçiş etkisi; 1980'li yıllardan itibaren akademik çevreler, parasal otorite ve piyasa oyuncuları oyuncuları arasında önemli bir araştırma alanı olmuştur. Döviz kuru geçiş etkisi, döviz kurlarında meydana gelen değişimlerin, ithalat mali fiyatlarından başlayarak yurtiçi fiyatlar genel seviyesi üzerinde belirleyici olmasını ifade eder.

Sigorta sektörü açısından problem; Hasar maliyeti ve prim fiyatlaması bağlamında önem arzetmektedir. Döviz kurlarında meydana gelen ani ve belirgin sıçramalar sigorta şirketlerinin hasar/prim oranı dengesini bozmaktadır. Bu durum aynı zamanda hasar karşılığı tutarlarında sapmaya yol açmaktadır.

Döviz kurundaki değişimlerin yurtiçi fiyatlara hangi hızla ve ne derecede geçtiğinin bilinmesi sigorta şirketinin iş modeli içerisinde, hasar yönetimi ve prim fiyatlama politikası üzerinden kritiktir.

Çalışmanın nihai amacı; döviz kur şoklarının "etki profilini" ortaya koyarak buna karşılık sigorta şirketlerinin kasko hasar maliyetleri üzerindeki olumsuz etkisini asgariye indirgeyecek bir çözüm önerisini sunabilmektir.

Konunun ele alınış ve çözümüne ilişkin izlenecek metodolojinin genel teması; Sorunun sigorta sektörü kapsamında ve "kasko poliçeleri" özelinde ele alınacak olması nedeniyle 1. Bölüm girişinde temel sigorta kavramları işlenmiştir. Poliçe "fiyatlandırma" konusu hem ticari boyutta ele alınırken temel net (risk) primi matematiği anlatılmıştır. Konunun, "büyük sayılar yasası üzerinden", "olasılık" boyutuna geçildiğinde, bir istatistiksel modelleme örneği üzerinden oto hasar sıklığı (frekansı) hesaplaması gösterilmiştir.

Bir örnek çalışma üzerinden, kasko hasar sıklığının tahmini için "Genelleştirilmiş doğrusal regresyon" modellerinden "Poisson" ve "Negatif binom" olasılık yoğunluk fonksiyonunun uygun olduğu görülmüştür. Sigorta sektörü verilerine dair "kaza eğilimi teorisinden" bir yaklaşımla bağlantılı olarak "Poisson dağılan" kazaların veri kümesi içeriğindeki ortalamanın hatasız olarak gözlenmesini imkansızlaştıran ve "Gama" olarak dağılmış "gözlenmemiş ayrık bir heterojenliği" de barındırmasından kaynaklanan Poisson dağılımına özgü "eş dağılım"

kısıtına karşın, “Negatif binom” fonksiyonunun içerisindeki “ek parametresi” sayesinde oto kaza hasar sıklığı modellemesinde bir adım öne çıktığı gösterilmiştir.

Hasar tahminine dayalı olasılık hesaplama sonuçları ve sigorta şirketlerinin geçmiş hasar tazminatları bilgisi “zaman ve tutar” boyutuyla birlikte, “zincir merdiven” metodu içinde işlenir. Böylece, sigorta şirketleri açısından “hasar tutarları” ve buradan da ayrılacak “hasar karşılıkları (rezervi)” bilgisine ulaşılmaktadır.

Olasılık hesabı üzerinden tekrar “fiyatlama” konusuna dönülecek olursa, “Net (risk) primi = Toplam hasar tutarı / Toplam sigorta tutarı” ilişkisi nedeniyle sigorta sektörü, olasılık matematiği, zincirleme merdiven metodu, hasar rezervi üçgeni içerisinde poliçenin minimum net risk priminin oluştuğu gösterilmiştir.

Sigorta sektörü açısından, döviz kuru şoku riskine konu olacak “hasar maliyeti ve rezervinin” nasıl hesaplandığı 1. Bölümde bu şekilde ele alındıktan sonra çalışmanın 2. Bölümünde döviz kuru dinamikleri ve enflasyon ilişkisi irdelenmiştir. Döviz kuru, “satın alma gücü paritesi” bağlamında ele alınmıştır. Enflasyon süreci “Fisher teorisi” ekseninde ve “parasal aktarım mekanizması” üzerinden ifade edilmiştir. Paranın değer kaybetmesi “doğrudan ve dolaylı” kanallar üzerinden açıklanmıştır. Böylece, döviz kuru şoklarının “enflasyon geçişkenliği bileşenleri” ortaya konulduktan sonra mekanizmanın çalışması “piyasaya göre fiyatlama” kavramının matematiksel çerçevesinde gösterilmiştir.

Çalışmanın 3. Bölümünde Türkiye’de 2003 ve 2017 yılları arasında döviz kurundan yurtiçi fiyatlaraa geçiş etkisi ampirik bir çalışmayla gösterimiştir. Burada, kurulacak model aracılığı ile değişkenler arasındaki ilişkinin gerçek hayata en uygun biçimde belirlenmesi hedeflenmiştir. Bu bağlamda, döviz kuru ve enflasyon olgularının kendi içlerindeki ve aralarındaki ilişkilerin denklemlerle ifade edilerek matematiksel bir kalıba oturtulması amaçlanmıştır. Değişkenler arasındaki ilişkilere işaret eden parametrelerin sayısal değerlerinin tahmin edilmesi, test edilmesi ve değerlendirilmesi süreci işlenmiştir. Değişkenler arasındaki bağlantıları kuran katsayıların tahmini ve testleri için oluşturulan ekonometrik modellede (EViews) matematiksel modele ilave edilen “hata payı” ile değişkenler arasındaki ilişkiler “deterministikten” (kesin), “stokastik” (rastlantısal) hale dönüştürülmüştür. Böylece, döviz kurundan enflasyona geçişkenliğin “mekanik yani fonksiyonel” işleyişi ortaya konulmuştur.

Uygulamada, enflasyonun geçişkenlik etkisi McCarthy (2000)’nin izlediği yönteme benzer biçimde uçtan uca bir süreç olarak ele alınmış ve etkileşimli bir denklemler sistemi üzerinden, eşbütünleşme ilişkisi ortaya konulmuştur. Bu yapıyla dışsal şokun üretimi sürecinin bir aşamasından diğerine ne kadar yansıtıldığı, döviz kuru şoklarının yurt içi fiyatları nasıl etkilediği gibi bulgulara ulaşılabilmektedir.

Sürecin matematiksel olarak ortaya konulmasında içsel ve dışsal değişken ayırımı net yapılmayan ve yapısal modeli üzerinde herhangi bir kısıtlamaya gidilmeyen (Eş anlı denklem sistemi modelinin aksine) zaman serilerinin analizi için "Vektör otoregresif model (VAR)" kullanılmıştır.

Literatürde, "durağan olmayan ve ko-entegrasyon ilişkisinin olmadığı" değişkenler arasındaki nedensellik ilişkilerinin tespitinde "Vektör otoregresif model (VAR)" öne çıktığı, "durağan olmayan ancak eşbütünleşik olan" değişkenler arasındaki nedensellik ilişkilerinin ortaya konulmasında ise "Vektör hata düzeltme modelinin (VECM)" öne çıktığı görülmüştür.

Bu çalışmadaki değişkenlerin zaman serileri "durağan olmayan ancak eşbütünleşik olduğundan" geçiş etkisinin yapısı (katsayıları) VAR'dan farklı olarak "hata düzeltme terimi" içeren VECM modeli üzerinden ortaya konulmuştur. "Etki-tepki fonsiyonları" ve "varyans ayrıştırması" üzerinden dönemsel olarak sayısal etkileri gösterilmiştir.

Değişkenler arasındaki "uzun dönemli ko-entegrasyon ilişkisi (vektörü)", VAR modelinde kullanılan "gecikme sayısı" üzerinden Johansen eşbütünleşmeyle belirlenmiştir.

"Hata terimi" içeren "kısa dönemli" VECM denklemindeki bağımsız döviz değişkeninin katsayısı ile bu "geçiş etkisinin gücü" ortaya konulmuştur.

"Hata teriminin katsayısı" ile kısa dönemde meydana gelen bir sapmanın, her dönem için hangi oranda düzelme (ayarlama) etkisi görerek ve ne kadar süre içinde "uzun dönem dengesine" erişeceği ortaya konulmuştur.

Sayısal sonuçlara bakıldığında; döviz kuruna gelen %1'lik bir şok dönemsel olarak ilk aylarda yüksek oranda Çekirdek TÜFE B'ye yansırken, bu yansıma etkisi ilerleyen dönemlerde simetrik olarak azalmakta ve 14. Aydan itibaren geçişkenlik etkisi büyük ölçüde kaybolmaktadır. Süreç olarak bakıldığında, döviz kuruna gelen %1'lik bir şok izleyen 2 ayda Çekirdek TÜFE'ye %16,0 oranında yansırken, 3. Ayda bu oran %37,89'a kadar ulaşmaktadır. 14. ay itibarı ile bu etki %50,3 seviyelerinde normalize olmakta ve stabilite kazanmaktadır.

Elde edilen bu "bilginin" sigorta sektöründe döviz kuru şoklarının ortalama hasar maliyeti üzerindeki olumsuz etkisinin çözümüne yönelik kullanılabilecek bir "yöntem önerisi" 4. Bölümde verilmiştir. Burada, 3. bölümde kullanılan yöntemlerden elde edilen "sayısal bulgular” bir “beklenen enflasyon endeksi” üzerine modellenerek etkileri sayısal ve görsel olarak ortaya konulmuştur.

Böylece sigorta sektöründeki finans ve aktüerya departmanları tarafından fiyatlama süreçlerinde pratik ve dinamik olarak kullanımı sağlanmaya çalışılmıştır. Buna göre, bir kur şoku sonucunda enflsayonist beklentilerde meydana gelen değişim dinamik olarak sayısallaştırılmış vegörselleştirilmiştir.

Sağlanacak avantaj ve katma değer; Türkiye’de sigorta sektörünün finans ve aktüerya çalışanları fiyatlamalarını (tarife) genellikle çeyrek veya yıllık dönemsel bazda yenilemektedirler. Ayrıca, geleceğe dönük kur etkisinin fiyatlara yansıtılmasında döviz kuru tahminleri ve “forward kurlardan” yararlanılmaktadır.

Oysa, yıl içerisindeki enflasyon bekleyişinde döviz kuru şoklarından kaynaklanan değişim, faizlerle beraber fiyatlar genel seviyesini dinamik olarak “sürekli” değiştirmektedir. Forward kurların tahmin olarak kullanılması ise yöntemsel olarak eksik kalmaktadır.

Sigorta hizmeti de, ticari malların aksine üretimi satışından sonra geçekleşen bir ürün olduğundan “bugünkü prim fiyatlaması” için, “gelecekteki” fiyatlar genel seviyesinin ne olacağının “kısa süre içinde” öngörülmesi önemlidir.

Bu nedenle, 4. Bölümde uygulaması tarif edilen ve kur şoklarının fiyat geçişkenliği etkisinin “ekonometrik” modellerden türetilen sayılar üzerinden net (risk) primi fiyatlamasına yansıtan çalışma yöntemleri daha sağlıklı ve gerçekçi sonuçlar üretecektir.

INTRODUCTION

Financial markets has reached the speed and capacity with which they can instantly calculate the pricing for every single development in parallel with the technological development and the globalization. The recovery process after the 2008 US Mortgage Crisis has developed on the growth axis based on the wealth of liquidity that lives on the world central banks. Developing countries have become attractive in terms of financial investments for global capital because of high borrowing costs compared to developed countries. In this process, the volatility of the local currencies of developing countries on the purchasing power has also increased together with the increasing and accelerating financial activity.

Exchange rate fluctuations and foreign exchange gains and losses are matters of interest of financial sector actors beyond being a topic which interests real economy players over risk management. Insurance companies, which are the institutions not bearing risk related obligations of the economy, may be negatively affected indirectly by the consequences of this situation.

When examined the insurance sector, the main field of this study, the effects of sudden and permanent exchange rate shocks are concentrated in two points. Contrary to the commercial goods, insurance service is a product whose production happens after its sale. Therefore, the claim/premium balanced established by the cost, probability and time value basis, the basis for pricing, may deteriorate due to the sudden exchange rate in anticipated inflation.

Again in this study, this corrupted claim/premium ratio balance is examined in detail in the subsection named "auto insurance". The reason for this is the sensitivity of the cost of repairing auto damage, which is the change in import prices. Unexpected currency exchange rate shocks, which shows pass-through to general level of prices directly, indirectly and monetary transmission mechanism, bring into question the technical damage issue together with increase in burning cost. Due to the auto insurance policies which constitute a large portfolio in terms of the insurance sector, it is important to manage the inflationary effects originating from exchange rates.

As an insurance sector employee, my awareness of the problems of the sector as well as my evaluations about the monetary issues of the sector have matured over time, this enables me to provide a solution for the issue.

A systematic solution proposal that analyzes the size and timing aspects of the inflation pass-through effect arising from sudden exchange rate increases and makes its numerical findings usable by the insurance companies constitutes of the purpose of this study.

I owe a debt of gratitude to my esteemed advisor Associate Professor Genco FAS whom I benefit his experiences, and employees of financial affairs and actuary department of Eureko Insurance Corp.. and my family who provide full support constantly.

March 2018 İsmail Telci

(Fund Manager)

1. BASIC INSURANCE

1.1 Concepts of Risk and Risk Perceptions

The risk concept subject to insurance and being insured means that general hazards that social life has on daily activities of people and which have potential to occur at any moment. These hazard factors subject to risk perception consists of the threats playing a part in the risk (Sjoberg, 2004).

As a subjective concept, the risk perception of the individuals is the whole thinking concept consisting of threatening probabilities that people can face in life and how measures should be taken against their consequences (Micelli et al, 2008).

In another approach, the risk and perception of risk are explained as a subjective assessment of the degree to which a coincidental event is likely to occur and the extent to which people are affected by its possible consequences (Rios et al., 2014).

1.1.1 Definition of risk in terms of insurance

In a definition that emphasizes insurance theory, risk refers to a complex and multidimensional concept beyond its expression of "uncertainty";"*Negative deviation of realized loss from expected loss"* (Kırkbeşoğlu, 2015). Because uncertainty in the insurer's perception does not have a risk value to a certain level. Inasmuch as the insurer has already predicted that the insured will be in danger for a period of one year and that there will be losses that could result in compensation. Compensation within this concept is loss of recoverable in terms of insurance.

The statistics on the losses that occurred in the past are noteworthy for the insurers. In the light of this information, the insurer calculates how much damage compensation will be incurred in the next year and in advance how much premium should be paid by the insured. In daily life, only some of the many insurers in the insurance pool will be confronted with possible damages. Therefore, these damages weighted through a specific risk possibility calculation can be compensated by the insurers. In other words, the insurance sector has already taken care of itself for such damages claims which can be expressed as "expected loss".

The insurance companies collect premiums from the insurers for possible damages they anticipate will occur in advance and create a pool. The premium to be collected from the insured must be sufficient to ensure that the potential future losses can be compensated. The amount of premium to be claimed has a critical importance at the point of providing the "premium-compensation" balance. For this reason, it will not be fair to take the same premium level from all insured persons. The insurer collects premiums by classifying the insured according to certain risk factors (age, sex, occupation, etc.).

1.1.2 Risk for insurer

If the acutarilly calculated premiums, in other words as a result of advanced statistical and mathematical knowledge, is collected, it is not expected and should not be expected the situation that that the future risks can not be compensated from the point of the view of the right insurance company. In case of exceptional circumstances such as natural disasters and abuse of insurance etc., the situation called "realized loss is more than expected loss", which is intrinsic to the insurance company, may arise (impairment of premium-compensation balance). The risk for the insurance company shows up at this point. The risk is defined here within the scope of "profit-loss" concept. In the insurance sector, it is expected that the mathematically calculated-direct premium will be collected from the insured, together with the assumption that the premiums are fixed in actuarial terms. In this context, the idea that the risk is originated from the change in the loss becomes true (Kırkbeşoğlu, 2015).

1.2 The Relationship of Uncertainty, Risk and Probability

Although the uncertainty is used synonymously with the risk, the uncertainty is a suspicion of the consequence possibilities of any future situation. In other words, It is a psychological reaction resulting from lack of information. The fact that whether the uncertainty is felt or not by the person doesn't change the real situation and the level of probability of loss due to relevant risk. Therefore, the awareness about the risk created by the uncertainty can't create a change specific to the existence (absence) of the risk. Similarly, a person exposed to a damage arisen from the risk, he has already a risk whether or not he is aware of the risk.

The relationship of the risk with the concept of probability is interpreted by the size of the risk, in other words, the probability of occurrence being relatively low or high. Although the instinctive suspicion puts forward the risk, which has the higher damage possibility, the size of the potential damage is actually a function of the probability that the expected event will certainly happen at what level.

The possibility of claim (loss and damage) consists of objective and subjective parts. Probability in objective sense can be calculated by deductive and inductive assumptions. For example, in head or tails, the possibility is 1/2. The subjective probability defines the likelihood that people "consider" about themselves. Some people feel that they are more "lucky" on some days (they believe that their chances of winning higher increase because of other than mathematical reasons).

1.2.1 Claim and probability relationship in definition

In English, Peril is defined as a cause of claim. For example, if rainy weather and bad road conditions are active in the occurrence of a chained traffic accident, the conditions that cause this result are called as Peril. Although it comes to existence with the occurrence of peril damage, it is actually a situation that happens constantly in everyday life.

Again, in English, the word "hazard" refers to the situation creating loss caused by Peril. For example, if a traffic accident caused injury or property damage, traffic accident would be a Peril here. However, if it leads to loss of life and other material / moral losses after a traffic accident, the traffic accident is defined as a hazard that creates conditions that increase the likelihood of a loss.

1.2.2 From risk types: clean risk

The concept of bare risk is used in situations in which there is loss or not are valid. Bare risks have an important place in the risks which are within the scope of insurance. For example, a person's car may or may not be able to suffer from a damage in a year. However, in either case this person does not gain any additional benefit from the results of these two situations. There is no probability of winning (gainings) at bare risks. As stated in the example of automobile, "property related risks" are covered in this context, descriptively.

With the same logic, insurance is not an unjust enrichment factor. Since the purpose of the insurance is to ensure that the individual is in a state before the loss, it does not create a value increase in the assets of the persons after the compensation of the damage. For this reason, speculative (such as gambling) risks are not guaranteed while bare risks are secured in insurance. Insurance is essentially a structure, which rejects the speculative risks possibilities having profitability in its own and is separeted from the gambling.

1.2.3 From risk management to insurance

Risk management is a scientific process involving the reduction or elimination of risks with which a company is facing (Vaughan, E.J. and Vaughan, 2008).

Risk management is a systematic process in which risks are identified, which risks need to be solved first, and strategies and plans are developed and applied to measure risks (TÜSİAD, 2008).

While risk management conceptually got its the first reference in the Harvard Business Review in 1956, during those dates this view was revolutionary. When the risk management in the corporate context is expressed as the organization of the bare risks of the companies, this definition crated the roots of this concept. During those dates, that the bare risks were in the context made insurance be highlighted as the sole institutional risk management factor. Then, the transition from insurance to corporate risk management has been an inevitable evolutionary process.

1.3 Insurance and Insurance Business

One of the most effective way to cope with the risks is to transfer risk. At this point, the concept of insurance comes into effect (Kırkbeşoğlu, 2015). The insurance industry, one of the main indicators of economic and social development, is also one of the three main pillars of the financial sector. Insurance, as a risk transfer technique, is based on the principle that the losses of damaged individuals due to unfortunate events are distributed to many other actors in the system.

For example; assuming that in a car park consisting of 1,000 cars, the value of each vehicle is 100,000 TL. If historical statistics show the probability of a vehicle being damaged is as 0.1%, we can only make assumption about the possibility of an accident for one vehicle per year in the car park; this also means that the total cost of the yearly-expected cost of damage is TL 100,000. In other words, the pool to be formed by paying a premium of 100 TL per capita to the owners of the other 1,000 vehicles will be sufficient to meet the minimum amount of possible damage.

As we can understand here that, the insurance is based on two basic functions;

a. Transferring the risk from an individual to a group (distribution).
b. Sharing of the cost of the damage to all members in a common pool.

According to this, insurance means that a system that carries out some work with people who performs this as a profession and brings together homogenous people, and creates a pool for risks that individuals do not want to carry and performs the compensation from this operated repository in case of damage.

1.4 Law of Large Numbers and Probability Theory

While the pool system constitutes the foundation for the processing of insurance activities, the precondition of this process to continue in a healthy way is that the calculations based on damage estimation probabilities and the corresponding calculation of the premium pricing are required to be mathematically perfect. As a result of this, it is possible to establish a healthy premium-compensation balance.

While the precision of the insurance's probability calculations plays a critical role in the formation of this balance, the foundation of these calculations extends to the "law of big numbers" in mathematics.

Probability theory refers to the measurement of the probability of occurrence of an event and the estimation based on this measure. It is based on the idea that seemingly random events can actually happen with more than one practice.

The objective probability concept, which should be emphasized at this point, indicates that the formation of the probability level assigned to one event is determined by different and more than one independent practices. It is mathematically and intuitively clear that the probability of heads or tails of a genunine coin is 1/2 0,5 (%50) in deductive method, which the objective probability comes to the forefront. These inductive calculations made in this way are called as a priori probabilities (Kırkbeşoğlu, 2015).

In a single coin throw, heads or tails cannot be precisely predicted. However, it is expected that half of the results of a sufficient number may be heads or tails. The accuracy of this result is known intuitively. This is the intuitive acceptance of the law of large numbers, which states that "as the number of observations of an event approaches to infinity, more real possibilities are approached" (Vaughan, E.J. and Vaughan, 2008).

In the event of the circumstances are equal, probability is the ratio of chances suitable for realizing to the general chances. In other words, the values of experiences increase to the infinity, the difference between frequency and probability converge to the zero theoretically.

1.4.1 Law of large numbers and insurance companies

According to the "Law of Large Numbers" the more data on hand, the closer the calculations to be carried out in the future will converge so much to the truth.

In accordance with this if, it is not possible to make a calculation to include the entire population, a sample selection will be required. The relevance of the sample taken by the relevant population to the accuracy is directly proportional to the size of the sample. The greater data set, the higher realism of the estimations.

The meaning and the importance of this concept for insurance companies are to make many examinations about the making estimations and this leads to more accurate probability calculations. The insurance company sees opportunities to identify prospective expectations based on experiences.

On the other hand, it is likely that the insurance companies will also have to calculate the extent to which the actual experience is estimated contrary to the calculated expectation (Vaughan, E.J., and Vaughan, 2008).

1.5 Characteristics of Risks Subject to Insurance

Insurance companies do not want to insure all risks because of cost-based concerns. Risk is expected to carry some qualifications in order to be eligible for insurance;

a. Having a large number of insureds
b. Claim is coincidental
c. Claim is determinable
d. Claim isn't catastrophic
e. Claim is calculable
f. Premiums have economical flexibility

1.6 Types of Insurances

The first differentiation in the diversity of today's insurance products consist of private insurance and social insurance. Social insurance is state-sponsored protection against some basic risks with which the community faces. In the literature private insurance is classified as return insurance, in other words compensation insurance (Kırkbeşoğlu, 2015).

Compensation insurance aims to compensate the real economic value of the claims faced with materially. The amount of insurance written in the policy determines the liability of the insurer. Compensation insurances cannot be written on the actual cost and if the risk happens, the insurer pays the guarantee amount written in the policy to the insured.

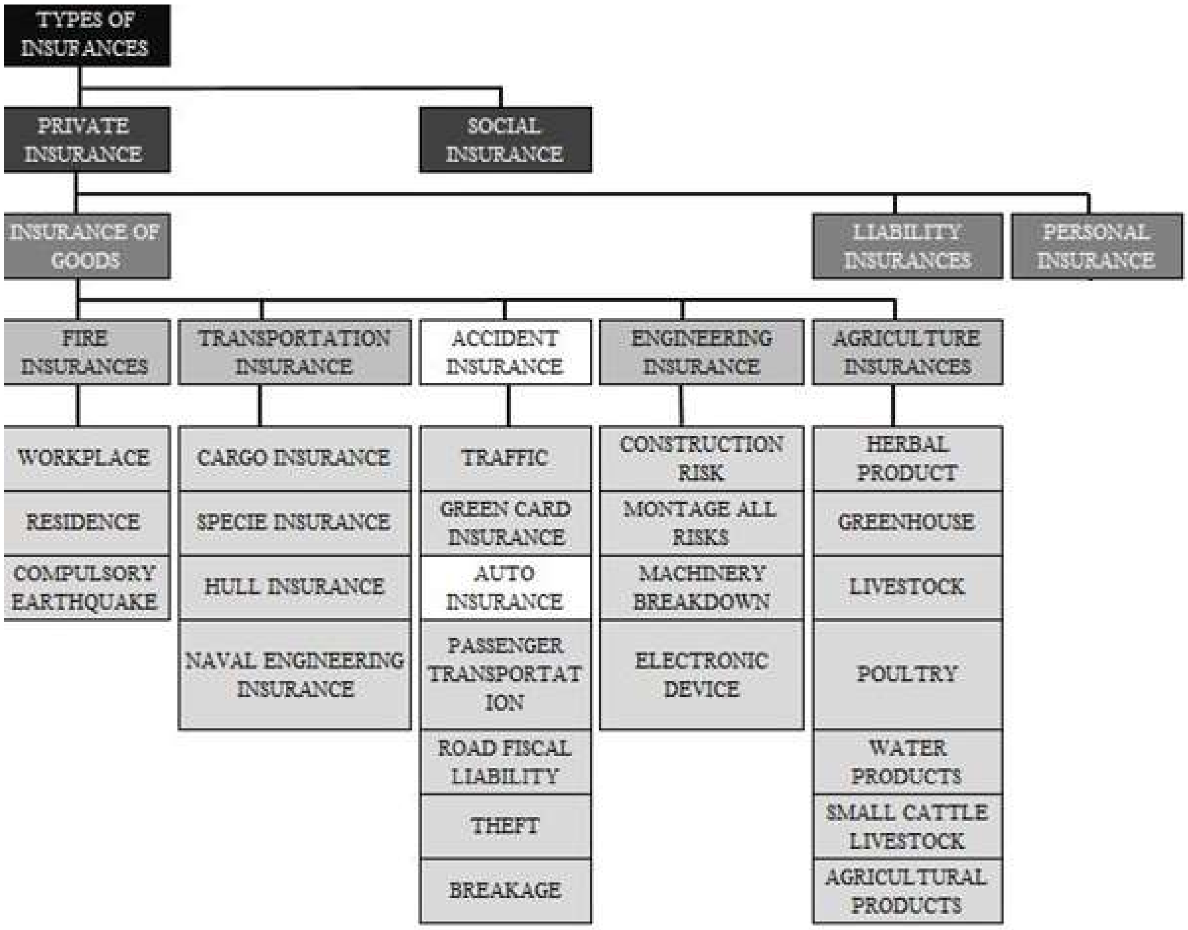


Table 1. 1 : Elementary Types of Insurances.

As seen in Figure 1.1, insurance of goods under private insurances aims to compensate for the financial losses on concrete goods (machinery, vehicles... etc) (Güvel and Güvel, 2008).

Accident insurance from the lower branches of insurance of goods is an important part of the overall risk of the portfolio of the insurance companies in Turkey. While application is divided into auto and non-auto insurances, comprehensive insurance is included in the auto insurance in the sector (SEGEM, 2013).

1.6.1 Motor vehicles insurances

Living together and technological progress have an increasing importance in today's communal living and also brıng some risks, too. Responsibilities of individuals, which increase in the common ground of the public, cause that they cannot carry some risks alone. These types of complex risks arise due to the need to secure collateral in order to compensate for the physical and material damage that individuals may be able to give themselves and others due to their activities in every day life.

Motor vehicle insurances are important service in terms of protecting the peace of mind in social life and social responsibility in terms of the individuals facing the risk of paying compensation due to the damages they will do harm to another person.

Practises of motor vehicle insurances;

a. Traffic Insurance
b. Voluntary Financial Liability Insurance for Motor Vehicles
c. Auto Insurance
d. Compulsory Road Passenger Carrying Insurance
e. Compulsory Road Transportation Financial Liability Insurance
f. Assurance Account

Auto Insurance; insures the pecuniary damage that will be directly incurred in case of the risk of the benefits arising from motorized and non-motorized land vehicles, trailers or caravans, wheel tractors, duty machines, agricultural machines.

a. Collision of the vehicle with motorized and non-motorized vehicles used on railway or highway.
b. An accidental crash such as an object hit the vehicle or vice versa, falling, turnover, rolling etc. except for the insured or someone else's decision in the event of the vehicle is moving or stationary.
c. Accidents that will occur due to the activities of third parties.
d. Burning of the vehicle
e. The vehicle or its parts being robbed.

This type of insurance is valid within the geographic boundaries of the territory of Turkey.

1.7 Insurance Businesses and Actuary

Actuary departments can be organized under the technical assistant general manager or directly under general supervision in the insurance companies. The Actuary word comes from the Latin word "Aktuarhis" and its history dates back to 1762 UK in practice.

The duties of actuaries and actuary departments in insurance companies;

a. The pricing of premiums by evaluating the risks to which the insurance company may be exposed.
b. Determination of the amount of charge (commission, charge) to be collected from the policyholders.
c. Calculation of compensation amounts for possible risks.
d. Calculation of reserve amounts for possible compensation payments.
e. Determination of pricing and collateralisation structure for developed products.
f. Regulation of premium rates.

1.8 Insurance Pricing

In simple terms, insurance may be called that it is the job of assuring against the risks in a certain premium that individuals and institutions will be exposed to and when the risk happens, it is also the payment of the compensation on the axis of certain guarantee limits. If the risk (hazard) becomes an event and there is a claim situation, the compensation of this claim is the guarantee of the insurer's assurance against the risk (Sergici, 2001). According to this, the most simple mathematical equilibrium expression of the insurance is;

$$\text{Total of Claims} = \text{Total of Premiums to be Collected}$$

The critical element in this definition is "risk premium" and it is calculated based on historical damage data statistically and mathematically. Operational expenditures to be included to this will be converted to the tariff premium from the minimum risk premium together with the production costs (Kahya, 2011).

The concept of tariff premium refers to the tariff making function in insurance. The pricing case in insurance describes the damage to be incurred when the risk occurs according to the probability of damage of various risks and the process of researching the technical profitability figures to meet the cost required to execute the insurance organization (Uralcan, 2005).

The companies have been able to determine their own premium price tariffs in Turkey since 1990. The main objective is that the companies create their own statistical databases and develop their pricing policies with mathematical models based on them, accordingly ensure to develop new collateral and product types.

However, in reality, it is seen that the insurance companies have pricing policies designed to be only competitive and to gain customers at the cost of moving away from technique instead of preferring price policies reflecting the real risk value and based on scientific risk expertise (expertness). This situation confronts companies with some possibilities such as falling of technical profits, thus decreasing in financial income, reinsurance (risk transfer, double insurance) decreasing the quality of placements and bankruptcy (Kahya, 2011).

It is expected that the company will determine the tariff premium rates based on the cost elements in the tariff determination and by using the historical data to determine the tariff premium rates in insurance premium pricing.

In order to prevent the violation of the price of the companies, a rational tariff adjustment which will constitute a basis for their prices will ensure that they are at a level which can meet the risks they undetake. since the damage paid to property insurances, including accident and automobile insurance, can vary considerably in terms of year and insured, at this point the importance of calculation accuracy is increasing.

A good pricing policy should be balanced, by providing the insurance company with the best service to its customers, while also providing reasonable profit to its shareholders. While the pricing case is at the center of financial sufficiency at this point, the usage of technical and statistical methods are required. It is generally accepted that the assumptions of the insurer's premium rates are determined by taking into account the expected damage cost, fluctuations in damage cost, commissions, overheads and target profit in this framework (İyidoğan, 2000).

the price determined based on law of large numbers, probability mathematics, mathematical models where past statistical data are used should be premium amount which can be paid to increase the market share and will provide the most profit once the loss compensation is met in the context of free competition and free tariffs (Uralcan, 2005).

The coverage rate is determined and then the insurance premium is determined after the insurance company decides to undertake the risk.

In terms of cost formation, the tariff premium with the risk to be exposed are determined as follows;

$$Basic\ Risk\ Premium + Cost\ Charges = Costings + Profit\ Margin$$

(Kürklü, 1997).

1.9 Law of Large Numbers and Pricing for Specific Groups

When comparing insurance and industrial production, the insurance product is not a pre-determined product or semi-finished product as well as neither raw material nor having material valueFirst "Insurance Service" is sold, then it is produced. In other words, the version of the product is before the completion phase. There is a commitment and acceptance of a premium payment for the compensation of damages for which the probability of the future can be calculated. The biggest problem faced the pricing of the insurance service is the uncertainty of this future possibility (Kahya, 2011).

Insurance function, as a main process, is the act of distributing an individuals' damage together with other individuals who are exposed to the same hazard. It is sort of financial solidarity. Therefore, the insurance premiums (contributions) to be paid by a large number of individuals will form a common fund and the loss of a few individuals who are directly faced with risk will be covered from this fund. The critical information at this stage is that since the risks involded in the pool will have different characteristics, the corresponding contribution will be differentiated to reflect to weight and the value of the pool. The premiums of the risks, which are much more exposed to the hazards, will be higher. In other words, the size of the risk is one of the variables affecting the premium price.

The aggregation of individuals/institutions that are close to each other in terms of risk levels has the meaning for a collection of similar units in terms of the frequency of damage and the average damage magnitude. Therefore, as the number of individuals/institutions that will be gathered within certain groups increases, it will become possible to make more effective use of "Law of Big Numbers" and the realism aspect of premiums to be applied in respect of the insured will increase.

"The Law of Big Numbers" in terms of insurance literature, "If any event can be repeated in large numbers, the results obtained as a result of these iterations confirm the theoretical results calculated for that event". In other words, the higher the quoted value, the better the probability that the related event will become.

If a number of results of the risk are collected, the result can be regarded as the probability of the theoretical realization calculated for the hazard, according to the "Law of Large Numbers" in terms of insurance profession.

1.9.1 Generally insurance pricing and primary factors

Both internal and external factors are influential in the pricing mechanism.

The internal factors of the business consist of marketing objectives, accepted marketing karma, costs and organizational structure of the business.

External factors subject to the pricing consist of market structure, competition, demand variety and other environmental factors.

While here costs are constitute the foundation of the pricing, consumer perceptions creates a base for the peak. Businesses should consider pricing policies of the competitors and internal and external factors of the business in order to determine optimum balance prices between these two end points.

The approaches that stand out in pricing decisions are;

a. Cost-based pricing approach.
b. Pricing approach based on demand (market).
c. Competitive pricing approach. These two groups consist of sub-strategies such as following up price leader, close bidding, price skimming of the market and market penetration.

1.9.1.1 The features of insurance coverage premium (price)

The concept of "premium" in the insurance literature is identical to the concept of "price" in the economic literature (Yavaşi, 2004). Although the trade is progressed through the decision of acceptance or refusal of the customer for the price which the insurer "calculates" in terms of insurance products, the basic price model on the junction point of the classical supply and demand curve is also valid in the insurance sector (Soysal, 1999). But of course, the price is not the most important factor in purchasing a very special service such as insurance. The reliability of the insurance business, equity capital, fast and quality service in case of damage are influential in decision making process.

Figure 1.1 : Definitions of Premiums in Insurance.

COVERAGE	The insurance company's main product, the assurance it gives.
GROSS PREMIUM (In terms of the insurer)	The coverage of the risk which the insurer has.
GROSS PREMIUM (In terms of the Insured)	The sum total of the fee the policy holder will pay.
NET PREMIUM	The expression of the risk mathematically, the coverage for basic risk (risk premium).

The insurer determines the total insurance premium (fee) by taking into account the profit margin which will provide the insurance commission payment, service expenses and reasonable profit on the insurance commission, except for the risk premium (Kahya, 2011). It is expected that the desired technical profit will be achieved on the basis of this price so that the company doesn't get weak in terms of ability to pay, liquidity, ordinary activities and the ability to compensate for the damage.

Companies need to make their pricing with the goal of "a reasonable profitability measure" at this stage. "Pricing based on risk premium" stands out in terms of applicability and reliability in this respect. This method, the primary modern approaches for determining of insurance premiums, means the method which is used for detection for premium. This method can be handled in two ways as "Average Premium Method" and "Special Premium Method".

Average Premium Method; it is determined average premium for specific group and it is collected in advance at the beginning of the insurance period. There is no margin called good risk or bad risk in here.

Special Premium Method; the premium is determined by differentiating of features of each risk. For example, for an automobile insurance, the vehicle is classified (grouped) by type, brand, model, age of driver, occupation, gender etc. Therefore the good risk is priced different from the bad risk by differentiating the good risk and the bad risk.

Some risk groups are created and a certain type of average calculation is performed since it is not practically possible to establish a tariff system that will ensure that each risk is priced separately (Nomer, Yunak, 2000).

1.10 Inner Elements of Price

1.10.1 Net –risk - premium (variable cost element)

It can be considered as the point of connection with "the present value of the expected damage" of the insurance premium in the theoretical sense. This part is the first part "market price" in other words "gross premium". In insurance jargon it means "the rate of claim compenstaion". It is calculated by dividing the amount of claims that are possible to occur in a given period to the total value of the insured assets (insurance amount) which are exposed to the same risk in the relevant period.

It is called technically "Risk Premium" which determines the amount of premium that falls on the shares of these individuals regarding their risks in order that the damage can be compensated by sharing among similar exposed individuals. In the literature "Net Premium" (prime nette), "Pure Premium" (prime pure) terms are used as well as "Risk Premium" (prime de risque) (Blanc, 1977; Rychen, 1967; Besson and Picard, 1964).

This ratio must be calculated from the data of past damage events over a period of minimum 15-20 years in order to be able to produce healthy results (Gediz, 1998). Determination of the risk premium as accurately as possible is a prerequisite that this premium can be calculated to the extent that it can create a reserve that can meet damages to happen (Nomer, Yunak, 2000).

The risk premium depends on the following situations about how many individuals will suffer damage in a given time period in a particular insured group;

a. Damage probability, loss frequency, damage frequency, average expected damage numbers per policy.
b. Knowing the average cost of each damage (average damage amount, average damage amount).

The accuracy level of the calculations will determine the frequency of damage and deviation in average damage size. If the insurer anticipates a change in these two elements in the near future, it should be taken into account and reflected in the premium calculations.

The frequency of damage is found by dividing to “numbers of damages” happened in the past and “numbers of insureds” within the same period.

1.10.2 Net premium equations

Certain identities to be written over the numbers, amounts, totals and averages of "Premium" and "Damage" will mathematically shows us the way to the formation of "Net Premium";

$$Average\ Claim\ Amount\ (S) = \frac{Total\ Claim\ Amount}{Numbers\ of\ Claims\ Incurred}$$

$$Average\ Insurance\ Amount\ (M) = \frac{Total\ Insurance\ Amou}{Total\ Insurance\ Number}$$

$$Net\ (Risk)\ Premium\ (P) = \frac{Total\ Claim\ Amount}{Total\ Insurance\ Amount}$$

$$Average\ Claim\ Cost\ (L) = \frac{S}{M}$$

$$Claim\ Frequency\ (H) = \frac{F}{K}$$

$$Net\ (Risk) Premium\ (P) = Claim\ Frequency\ (H)\ x\ Average\ Claim\ Cost\ (L)$$

$$(P) = (H)\ x\ (L)$$

$$= \frac{F}{K}\ x\ \frac{S}{M}$$

$$\frac{T.Claim\ Amount}{T.Insurance\ Amount}(P) = \frac{Number\ of\ claim\ incurred\ (F)}{No.of\ Insured\ in\ Same\ Time\ P.(K)}\ x\ \frac{Ave.claim\ Amount\ (S)}{Ave.Ins.Amount.(M)}$$

$$\frac{T.Claim\ Amount}{T.Ins.Amount}(P) = \frac{No.of\ Claim\ Incurred\ (F)}{No.of\ Insured\ in\ Same\ Time\ P.(K)}\ x\ \frac{\left(\frac{Ave.Claim\ Amount}{Claim\ Amount}\right)}{\left(\frac{T.Ins.Amount}{T.Insurance\ Number}\right)}$$

(H) Frequency of Incurrence of Claim (Frequency)

(F) No.of Claim Incurred

(K) Number of insured in the same time period

(L) Average Claim Cost (severity-the average amount of claims paid as compensation in the same period, the ratio of the amount of the insured in the same period to the average amount of the claims,)

(S) Average Claim Amount

(M) Average Insurance Amount

(P) Net (Risk) Premium (Claim Ratio, Claim-Premium Ratio)

The basic flow of this basic calculation is shown on the sample as follows;

Table 1. 2 : Claim Premium Ratio and Net Risk Premium Calculation

Insurance Policy Value(Coverage)		100.000	TRY	(Each One)	
Insurance Amount		10.000	people		
Total Damage Amount		100	amount		
Total Damage Cost	100 amount X 100.000 TRY Full Damage		=	10.000.000	TRY
Total Insurance Cost	10.000 people X 100.000 TRY Coverage		=	1.000.000.000	TRY
Net (Risk) Premium (P) = Total Damage Cost / Total Insurance Cost			=		
Net (Risk) Prim (P) = 10.000.000 / 1.000.000.000			=	0,01	
Risk Premium Amount to be Collected from Each Insured = Insurance Value Coverage X Risk Premium					
Risk Premium Amount to be Collected From Each Insured Amount = 0,01 X 100.000 TRY			=	1.000	TRY
Total Risk Premium Total Amount to be Collected from All Insured			=		
10.000 people X 1.000 TRY Net Risk Premium			=	10.000.000	TRY
TOTAL RISK PREMIUM COLLECTED = TOTAL DAMAGE AMOUNT TO BE PAID					

Here, the damage/premium ratio is the "break-even" state.

Production cost share - commission (fixed cost factor): The ratio of the expenses such as commission given at the relevant insurance branch, intermediary and similar expenses to the premium income.

General Expenses Share (fixed cost factor): Included share in return for expenses such as personnel fees, agency costs, advertising expenses etc. which the insurance companies face with.

Safety Margin –Margin of Safety -, Catastrophe Margin (fixed cost factor): There must be another share to cover the storm, earthquake or very severe exceptional damage that appears to be inherently risk premium but not detected according to past statistics in order to meet the deviations caused by unusual and unaccountable natural disasters in the probability of ordinary damage. In the event of these destructive conditions, the safety margin guarantee damage on the risk premium and installs an additional security function which will absorb any deviations from the expected damage. Generally, simply a percentage of premium is determined as a ratio of the standard deviation or variance of the damage.

The contents of "Gross Premium" together with the related concepts are as follows;

Table 1.3 : Gross Risk Premium Calculation.

GROSS PREMIUM
=
NET RISK PREMIUM
+
COSTINGS
Production Cost Share (Commission) General Expenses Share Safety Catastrophe Share Profit Share

Profit Share (Fixed Cost Factor): The economic purpose and function of a commercial business is to make profit. Insurance companies also have a natural interest in providing a reasonable profit to the owners of the capital. A "costing" will be added to the premium in order to provide this; therefore, it is a contribution to meet the equal cost of the capital connected to the activity.

With the addition of this concept, "Gross Premium" gains the "Commercial Premium" identity;

$$B = \frac{P}{1 - SM}$$

(B) Gross Premium Price, *(P)* Net (Risk) Premium (Variable Cost Factor), *(SM) Fixed Cost Factors*.

1.11 Formation of Premium, Time Dimension and Tariff System

Profits are generated in the process of production and presentation of cost-incurred process assurance service in insurance companies. The process from reaching the potential insurance customer, to offering and sellign the insurance assurance service, to the payment of the claim after incurred damage, realizes the process of income generation of the insurer. The fixed costs in the above-mentioned "costings" constitute a large part of the expenses of the insurer (Timur, 2006).

"Reassurance Costs" (Transferring part of all of their risk to other insurance or resinsurance companies by paying the price-premium by the insurance companies) of insurance companies and financing costs are other high cost items except for personnel expenses in the general expenses section (Kahya, 2011).

At the beginning of the premium determination process, some principles are observed, these are;

a. The premium is sufficient
b. The premium is fair
c. The premium is economically reasonable
d. The premium is encouraging about protection from damages

Sub-factors that affecting the premium determination process;

a. The progress of interest rates
b. The progress of inflation
c. The progress of foreign currency exchange
d. Competition
e. Statistical Data
f. Job Acceptance Policies

Policies are generally issued as "annual" in insurance sector. Pricing of the insurance policies are made in accordance with the tariffs. Insurance companies make their pricing based on these tariffs. Currently, the "Autonomous Tariff System" regime, in which the insurance companies determine their own tariffs and tariff policies in line with the statistics, is valid in Turkey. The public authority doesn't interfere the pricing of insurance companies except in cases such as urgent undercapitalisation.

Apart from marine transportation insurance, the method of determining the premium by dividing it into certain groups can find application areas in many other elementary (non-life) insurance branches. The frequency of damage and the average damage level are determined and various tables are used in insurance branches.

Net premium ratio is called as "Tariff Percent" in practice;

$Net\ Premium\ Ratio = Tariff\ Percent$

$Net\ Premium\ Amount = Insurance\ Amount\ x\ Tariff\ Percent$

1.11.1 From premium to the formation of tariff

The risk premium should be determined according to the principle of equality. In case of various damage premiums dependent on each other, for each risk;

Expected Value of Risk Premium = Expected Value of Damages

The equation is in the matter. However, the payment terms of premium and compensation will actually appear on different points on the timeline to create a "Market Price". Therefore, the time value of the money will be valid for the relevant time point and the "discounting" factor will be taken into account in the calculation;

Expected Current Value of the Risk Premium = Expected Value of Claims Current Value

When the pricing elements which form the insurance tariff within the scope of this equation come together, equation 1.1. which brings the "tariff" to the table will be as follows;

$$B = x_1P + x_2P + x_3P + x_4P \qquad (1.1)$$

(B) Gross Premium (Tariff Premium), (P) Net (Risk) Premium (Claim Cost), (x_1) *Net (Risk) Fixed - Tariff - Coefficient of Risk Premium Ratio,* (x_2) *Share of Production Costs (%),* (x_3) *Unit Share of General Costs (%),* (x_4) *Unit Share of the Profit (%).*

Here it is stated as “Paid Claim/Direct Premium Ratio” *(P)* Net Risk Premium in insurance literature;

Claim (Compensation) Premium Ratio= Incurred Claims / Earned Premiums

Briefly, basic variable called as “Claims Ratio” shows up.

It is a combining function of the elements of "the frequency of damage occuring", "the actual damage amount", "the insured value corresponding to the same time period", "average loss amount" and "average insured amount".

The ratio of "incurred damage" ratio in the "insured numbers corresponding to the same time period" as the "start" element on the road to the damage/premium ratio will be discussed and examined in the theoretical basis from the statistical and mathematical probability function in the following chapter.

1.11.2 The impact of inflation on premium

The premium value determined on time of the insurance policy in the local currency (T_1) will be different from the value of future damage in terms of purhasing power parity. This inequality become clear in periods when inflation as a concept beyond (T_2) "time value of money" is higher than anticipated inflation.

Especially when the damage compensation period is thought to be a time direction (T_1), "under-insurance" occurs at the time. While it is tried to increase the insurance amount with the help of "The Addendum and Subsequent Policy" in practice, it is not common in practical sense. On the other hand, it does not provide consistent results with price movements in inflation over the period they occur.

While the inflation doesn't have an impact on the frequency of damage (in numbers), it has an impact on the amount of damage compensations. In this case, it is necessary to adjust the insurance premium according to inflation. The amount of damage the insurer will pay is limited to the policy amount in the cases of insurances whose amount is determined in monetary amounts, in other words it is fixed. Inflation wears away this limit over time and the liability of the insurer will decrease in real terms. Similarly, insurance premiums are subject to inflation erosion except for advance payment (Dikmen, 2001).

While inflation reduces the value of the liabilities of the insurance companies relatively, it has also a negative effect on the return on alternative investment in terms of time value of the money in the collection process in terms of the premiums. It also reduces real value of the premium to be collected in the future. Therefore, this interaction between premium and compensation must be adjusted for inflation and it must be taken into the consideration in the determination.

The way to include inflation in the process is to take the inflation supplementary premium, namely "Inflation-indexed coverage clause". The policy is issued with the adjustment clause in the ratio mentioned on it and the determination of the insurance cost at the date of the damage is determined by the calculation of the agreed rate of insurance amount at the beginning of the policy and the day based calculation for the policies covered by the inflation (adjustment clause).

The additional premium which the company will collect from the insurer for the inflation clause should be equal to the additional amount that should be paid for the increased portion of the claim due to inflation. In other words, the company will operate this additional premium until the claim happens, and when the expected damage happens, it will pay the damage at full value together with the part including the real value increase by using this part (Küçükkavruk, 1994).

The value of the collected premium at the date of claim payment;

$$Value\ of\ Premium\ at\ the\ date\ of\ claim = \frac{(1-a)*K}{1+(i*t)} * \left(1+(i*m)\right) \qquad (1.2)$$

(a) Agency Commission Ratio, (K) Inflation Premium Ratio, (i) Discount ratio of the Company (interest), (t) Collection time of the premium (Average), (m) Duration of the damage (Average).

If the damage compensation is the additional damage amount at the time of payment it is the difference between full damage and damage amount (with ratio) except for “inflation clause.

Burada yine, sigorta şirketi açısından “büyük sayılar yasayı” ekseninde riskleri sigorta portföyü grupları bazında bölümlendirmeyle benzer mantıkta gidilmektedir. There is a similar logic for classification the risks on the basis of the insurance portfolio groups on the axis of "Law of Big Numbers" in terms of insurance company. Collection and damage compensation moments which are realized in different times are taken into account through the information of average premium collection and damage realization period and the premium is adjusted over the related inflation rate.

$$Additional\ Claim\ Amount = (H*L) - \frac{(H*L)}{1+(e*m)} \qquad (1.3)$$

$$Additional\ Claim\ Amount = (H*L) * \frac{(e*m)}{1+(e*m)} \qquad (1.4)$$

(H) Damage Claim, *(L)* Claim Level (Average), *(e)* Inflation Rate (Expected), *(m)* Claim Indemnity Duration (Average).

$$Value\ of\ Premium\ at\ the\ time\ of\ Damge\ =\ Additional\ Claim\ Amount$$

$$\frac{(1-a)*K*(1+(i*m))}{1+(i*t)} = (H*L)*\frac{(e*m)}{1+(e*m)} \tag{1.5}$$

1.12 Calculating Car "Claims Frequency"

1.12.1 Theoretical basis: stochastic (random) processes

In traditional Probability Theory, the probability of an event coming true is represented with a value considered within the set. This way, probability (possibility, chance) phenomenon becomes expressible with a real whole number between *[0, 1]* range. Hence, *(A)* simple event is appointed to a *(X)* random variable.

$$Simple\ Event\ \equiv Single\ Probability \tag{1.6}$$

However, in most reel situations, random events are dealt as a set or an array –as more than one– and based on random variables appointed contrary to these events.

$$X = (X_1, X_2, X_3, \ldots, X_n) \tag{1.7}$$

There is an alignment connection relationship meaning "later" between random variables with different values (vector) (< sign). This can be accepted as an "alignment" on a "time line". At this point, "time" aspect is added to the concept (Kayran and Yücel, 2016).

$$X_1 < X_2 < X_3, \ldots, < X_n \tag{1.8}$$

In probability universe, (S) is called the "random process" or "stochastic process" generated by defining $X\ (t, \rho)$ function for each (ρ) event dependent on a rule and time.

It is possible to express a "random process" explained with two fundamental parameters as a group of "random variables" that is indexed according to (t) parameter and defined on (S) probability universe in the $(X(t,\rho); t \in T, \rho \in S)$ T index group. Therefore, while (ρ) variable changes in (S) sample universe for a constant$(t = t_k)$, $X(t_k, \rho) = X(t_k)$ is a "random variable". If both (t) and (ρ) parameters are constant, $X(t_k, \rho_i) = x_i(t_k)$ is a "real number".

1.12.2 Theory of probability: bayes' theorem and conditional probability

Let's say that A and B are two events. A event can be expressed as;

$$A = AB \cup AB^c \tag{1.9}$$

Because if a point is present in *A,* it means that said point is either present both in *A* and *B* or it is in *A,* but not in *B*. Since AB and AB^c are "discrete";

For any B event, the set that includes all results of S sample universe that are not present in B, *B'*s integrant; B^c

$$P(A) = P(AB) + P(AB^c) \tag{1.10}$$

$$P(A) = P(A|B)P(B) + P(A|B^c)P(B^C) \tag{1.11}$$

$$P(A) = P(A|B)P(B) + P(A|B^c)[1 - P(B)] \tag{1.12}$$

The equation explains that A event's probability is "conditional probability" in case B event comes true and "weighted average" in case B event does not come true. Each conditional probability is weighted as much as its conditions become real. It is useful when trying to determine the probability of an event becoming real dependent on another event becoming real.

Against the challenge of directly calculating the probability of a single event, a second and related event's probability of becoming real is added into the equation to overcome the problem (Ross, 2009).

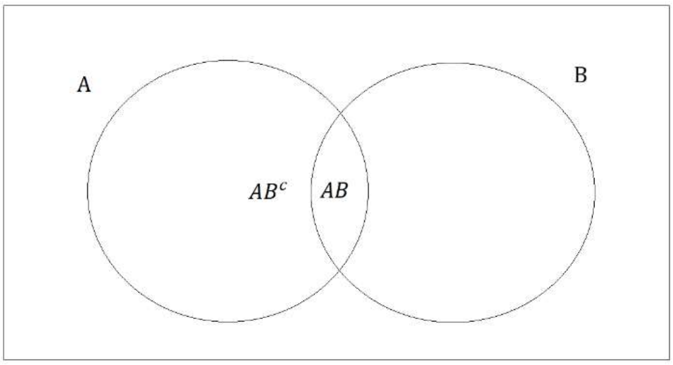


Figure 1. 2 : Bayes' Theorem and Conditional Probability

Example: According to statistics obtained from an insurance company, insurance holders are separated into two (2) groups as "low risk" and "high risk". Accordingly, within a "1 year" time period, "an" insurance holder in "high risk" group has the 0.4 chance of being involved in "an" accident while this probability ratio is 0.2 in "low risk" group. In accordance with this, assuming that 30% of insurance portfolio consists of "high risk" policies, the probability of "any" insurance holder within this portfolio being involved in an accident within 1 year period is:

(A_1) is the "event" of the insurance holder being involved in an accident within 1 year, *(A)* is the "event" of high risk portfolio,

$P(A_1)$, is the "probability" of being involved in an accident within 1 year.

$$P(A_1) = P(A_1|A)P(A) + P(A_1|A^c)P(A^c)$$

$$P(A_1) = (.4)(.3) + (.2)(.7) = .26$$

Assuming that "one" person within the portfolio is involved in an accident within "one" year, the probability of this said "person" being in the "high risk" portfolio is $P(A) = 0.3$

$$P(A|A_1) = \frac{P(AA_1)}{P(A_1)}$$

$$P(A|A_1) = \frac{P(A)P(A_1|A)}{P(A_1)}$$

$$P(A|A_1) = \frac{(.3).4)}{(.26)} = .4615$$

1.12.3 Classic: credibility and bayesian analysis

While calculating the value of premium, it is necessary to deal with the subject with a model in "Classic Credibility" – Bayesian – approach (Herzog, 1999). Bayesian approaches only consider the data that can be observed and assume that the groundmass is the variable. Thus, Bayesian approaches focus on the probability distributions of the relevant parameter (average) (Herzog, 1999).

It is assumed that in Bayesian Analysis, there exists a set of -data variable- risk factors grouped to evaluate the concept of pricing. Thus, when a single risk *(θ)* is chosen from a group that includes all risks, this *(θ)* decides on the content of the second set, in other words, the distribution function of *π(θ)*. Mathematical model for the $(X_1, X_2, \dots, X_n)$coincidental variables chosen from the second set with the same *π(θ)* distribution becomes real.

Each risk is expressed with its own θ risk, which means *(Θ)* coincidental variable becomes real. Here, *(Θ)* is the possible values set of all risk concepts in the portfolio (Bühlman, 2005). Accordingly;

a. $(X_1, X_2, \dots, X_n)$ coincidental variables with independent and co-π(θ) distributions are conditional in *(Θ = θ)*.
b. *(Θ, U)* is distributed coincidental variable.

In order to underline the claims regarding $(X_1, X_2, \dots, X_n)$ insurance holder, $f_{(X|\Theta)}(x|\theta)$ *(θ)* risk parameter represents conditional distribution of the claim. Claims that *(θ)* risk parameter is unknown regarding the insurance holder and happened in complete different timelines are accepted as independent from each other. Therefore, where $(X_1, X_2, \dots, X_n, X_{n+1})$ coincidental variables are independent from each other and dependent on *θ,* probability density function is (Panjer, 2008);

$$f_{(X_j|\Theta)}(X_j|\theta), \qquad J = 1,2, \dots, n, n+1 \tag{1.13}$$

When claims regarding a single insurance holder $(X_1, X_2, \dots, X_n)$ and θ risk parameter are known, aforementioned probability density function can be used to predict (X_{n+1}) claims.

1.12.4 Theory of statistics: Basic descriptions

Prediction; A certain value given to a random variable is called "prediction".

Random Variable; When assumed that the aleatoric result of an observation is the value of a variable, this variable in terms of probability and statistics is called "random variable". It can be discrete (which can only be expressed with a whole number within its defined range, can be grouped as frequency distribution, can be obtained with counting) or continuous (which can take all values within its defined range, can be grouped according to grades created in certain rules, cannot be obtained with counting).

Probability Distribution; Given that (X) is a discrete random variable – as an example – the values it can take and the probability of each value's (P) function expression is;

$P(X = x_i)$

Average is; μ (this value is at the same time the average of the probability distribution)

Discrete Probability (Luck) Variables' "Expected Value" is equal to the relevant variable's average $(\bar{x})$.

$$E(x) = \sum_{x} x_i \, P(x_i) = \mu \quad (1.14)$$

"Standard Deviation" of Discrete Probability (Luck) Variables (σ) express the dispersion of relevant variables (x_i) around the average ($\bar{x}$). Since square of the standard deviation (squared deviation) is equal to variance;

$$\sigma = \sqrt{\sum (x-\mu)^2 P(X)} = \sqrt{\sum x^2 P(X) - \mu^2} \quad (1.15)$$

Predictor (Parameter Estimator); "Predictor sample statistics" (averages, etc.) of the samples (a small part of the complete relevant data) *(Symbolized with Roman letters, small)* taken to predict the parameter of a groundmass (all data subject to examination) *(Symbolized with Greek letters, Capital)*, is a "random variable" dependent on the data obtained from the sample. The values it takes provides an approximate value on the unknown parameter of the groundmass.

Predictor without Deviation; If the average of a sample distribution $(\bar{x})$ is equal to the corresponding parameter of the groundmass (a numerical and measurable feature of the groundmass), this statistic is the parameter's predictor without deviation.

Since the "averages" average to the sample distribution ($\mu_{\bar{x}}$) is equal to groundmass average (μ), örneklem ortalaması $(\bar{X})$, anakütle ortalamasının (μ) "sapmasız" bir tahminidir.

$$\mu_{\bar{x}} = \mu \qquad (1.16)$$

However, sample distribution average of the sample "variance" (expected value/average of the square of the distribution – mass variable – average's deviation) is;

$$\mu_{s^2} = \frac{n-1}{n}\sigma^2 \neq \sigma^2 \qquad (1.17)$$

Sample variance (s^2), is a prediction of groundmass variance (σ^2) with "deviation".

1.12.5 Mathematical statistics: Probability distributions

Non-life insurance premium calculation is a process that depends on the true estimation of claims payment frequency according to the theory and statistical data obtained from past records. An important step of insurance premium calculation is to accurately pre-define the insurance holder's risk level. Regression analysis of the counted data makes it possible to define risk factors and predict the expected claims frequency according to insurance policy holders' features.

The goal of this section of the study is to interpret the models depending on statistical data obtained by counting and to define risk factors that explain claims frequency. Throughout the study, "Negative Binomial Model" will be examined in addition to standard examination of "Poisson regression". Best model in application is determined by the average of "logarithmic probability" ratios and criterion towards presenting meaningful information. Depending on these models, profiles of high-risk policy holders are determined.

Communal living incorporates risks that may bear economic consequences and may need constant administration. As a civilization exposed to risks, the need to be protected against them is prominent, more than ever, which eventually resulted in the need – demand – to be protected against possible financial losses. Appearance and development of the insurance industry has a close relationship with the imminent need of individuals have to protect their assets against the "possibility" of a certain event.

Therefore, "being covered by an insurance" or "being an insurance holder" are defined as a just method to transfer the risk of conditional or undefined cost.

In the "non-life" branch of insurance industry, especially of private insurances, accident insurance and motor vehicle sub-branches are always in the foreground. The main reason for this is the increasing vehicle number and insurance holder number includes multiple various risks that need to be managed.

One of the main goals of insurance companies is to determine the accurate insurance premium (price) for each insurance holder to meet a specific risk. A well-known method to calculate said premium depends on the fact that expected frequency regarding the condition of claims indemnity is a function of expected cost of the claims indemnity. Therefore, a small "sample" obtained from a larger "groundmass" like "automobile accidents" obtained by data counting and its frequency modeling represent the most critical stage of calculating the "frequency" parameter required for the pricing of claims indemnity request.

Automobile accident statistics fact is an example of variables obtained through data counting of "dependent variables". Underlying variable for each case is a "discrete" variable that takes only limited "non-negative" values (including zero) during a limited period of time. Regression analysis of accounting data makes it possible to define related risk factors and predict the expected claims frequency in accordance with these risk features (Boucher and Guillen (2009).

As the dependent variable in modeling, total automobile "accident-claim number" happened in "one day" is used. At this point, since the dependent variable is "discrete" and consists of only "non-negative whole numbers", classic regression models cannot provide predictors without deviation. Main reason to this is that observations cannot present a normal distribution since the dependent variable consists of "count data". If the sample focuses on a couple of small discrete variables, the model should be preferred among those regarding accounting data (Cameron and Trivedi, 1998; 2005).

Accounting data contains rare or non-frequent events happening in one (1) year, like automobile accidents. To ensure realistic modeling of such events, utilization of probability distribution models that can use the specific features of accounting data is needed. For such a probability distribution, “Poisson probability distribution model” comes to the foreground. The regression model depending on probability distribution is called the “Poisson Regression Model” (PRM). An alternative to PRM is “Negative Binomial Regression Model” (NBRM), which is based on negative binomial probability distribution and comes to the foreground in eliminating PRM’s certain deficiencies.

1.13 Modern: Generalized Linear Models - GLMs

There has been an ever-increasing interest in the explanatory models of accounting data in the academic circles anMod business world since the recent past. An important milestone for developing accounting data models was the creation of “Generalized Linear Models – GLMs” (Cameron and Trivedi, 1998).

Poisson regression, developed by Nelder and Wedderburn (1972) and later detailed in (Gourieroux et al. 1984a, 1984b) articles, is an important example of GLMs. Poisson regression is used in panel data (a time-series that simultaneously includes multiple units and multiple observations periods) (Hausman et al., 1984) studies.

Use of GLM techniques in non-life insurances industry has shown that Poisson distribution is prominent and determinant while predicting claim frequency (McCullagh and Nelder, 1989). Thus, Poisson distribution was widely accepted as the prototype model for predicting claim frequency (Antonio et al., 2012).

In spite of the intense attention from statistics world, Gourieroux and Jasiak (2001) emphasized important restrictions that limit the practical use of Poisson Distribution. At this point, they remarked the equality of variance and average in Poisson Distribution. “*Equidispersion*”, which is the most basic feature of Poisson Distribution, forms a special shape of “unobserved heterogeneity”. Poisson Regression model is generally criticized for this aspect.

The criticism arises from the fact that all moments of (y) depends on (λ) parameter, because distribution has a single parameter (single-parameter structure) (Cameron and Trivedi 2005). According to this, one of the most important deficiencies of Poisson model is that it ignores the variance exceeding groundmass average (*overdispersion*). $(s^2) > (\mu)$.

While many studies were put forward to overcome this inherent constraint of the model, other models were worked together for the same goal.

Accordingly, for when the variance is greater than the average, predictions made by using Poisson model lose their efficiency. One of the models suggested to overcome the problem of variance being greater than the average is *"Negative Binomial-NB"* model (Kılıç, 2014). Negative Binomial distribution is, in literature, is one of the most prominent examples of alternative approaches that handles the constraints of Poisson distribution in a controlled way and creates similar qualitative results through simple and effective techniques. In statistics literature, many ways are proposed to create Negative Binomial distribution, but the most functional ones are NB1 and NB2 forms created by Cameron and Trivedi (1998).

Recent era studies (Denuit et al., 2007) show that Negative Binomial model offered as an alternative to Poisson distribution model in predicting demand frequency of auto insurance portfolio has a promising feature in this sense.

Studies based on insurance industry data obtained from random sampling show that comparing "log-probabilities" for both dispersion types (Boucher et al., 2007) improves the accuracy of data in negative Binomial distribution's additional parameter when compared to Poisson distribution. In literature, there are analyses that include practical usage of negative binomial models for automobile insurance data in (Boucher et al., 2008), (Boucher and Guillen, 2009) and (Antonio and Valdez, 2010) studies.

1.13.1 Statistics modelling: Car claim frequency

1.13.1.1 Determination of parameters of probability distribution

Another prominent area of non-life insurance pricing literature is how to define the "variable" that helps predicting the risk frequency of a certain insured group and how to determine the "type" of mentioned variable.

A standard classification will include the followings: age, gender and marital status of the insurance owner, intended use of the insured vehicle, the geography in which the vehicle is, whether the vehicle has sport qualities, and so on (Antonio and Valdez. 2010).

Kouki (2007) created a more systematic classification model that groups risk factors into three main categories:

a. Driver; Age, gender, driver's license issuing date, bonus-malus coefficient (scoring system for good/bad drivers).
b. Vehicle; power, model year.
c. Features of the insurance policy.

Experimental studies within this context are important because they apply theoretical hypothesis factors on a real insurance portfolio and researches a solution from there on (Charpentier and Denuit, 2005), (Yip and Yau, 2005), (Denuit et al., 2007), (Allain and Brenac, 2012), (Boucher et al., 2013). The results of these studies are used as calculating tools developed by insurance companies while they are also very useful to develop solution suggestions for the changes in customer behavior and features.

The main goal of this study, which focuses on automobile insurance business, can be presented in two stages: first one is to create a synthetic and theoretical model for the automobile claim frequency in a theoretical and methodological sense. The second part of the study will comparatively emphasize other studies in the literature by underlining the difference between two statistical probability dispersion model for automobile claims frequency.

1.13.1.2 Methodology

The fact in question here is regarding the liability of an insurance company as a third party within the framework of insurance amount in case of an automobile damage.

As a sample data set, 9 exogenous variable parameters are determined below. This way, it is possible to create statistics for variables set of 10 parameters. At this point, all variables except variable number 1, "claims frequency", (the variable with a determined number) are classified as "risk factors" pre-determined by the insurer. Relevant 3 main risk classes are the driver, vehicle and policy features. Other risk titles (variables) form the sub-groups of main risk classes given above.

Table 1. 4: Risk Grouping Based Age Classification.

NO	VARIABLE	DESCRIPTION	VALUE
1	Number	Frequency of Claims	0-5, declared
2	Age	Age of the Insured	18-75 Years
3	Profession	Profession of the Insured	Employed, Housewife, Retired, Self-Employment, Unemployed
4	Type	Vehicle Segment	A, B, C, D, E, F,
5	Category	Vehicle Size	Wide, Medium, Small
6	Use	Intended Use	Private, Proffessional, Other
7	Price	Market Value of the Vehicle	10.000,00-4.000.000 TRY
8	GPS	GPS	Yes, No
9	Bonus	Bonus-malus extent	-50 points and + 150 points
10	Period	Period of insurance	0 -15 years

"Bonus-malus coefficient" within these variables have a different importance for each country and insuring system for pricing. Negative (-) or positive (+) change of the numerical value of said variable within the insurance owner's responsibility amount in his declared claims history will have a positive (bonus) or negative (malus) effect on the insurance owner's next term policy price (risk premium). While the basis coefficient starts out here as (1), it corresponds to the net (risk) premium the insurance company takes as reference. Specific application may work as following: if there are zero claims declared for the past 1 year, a 5% positive discount may be applied on net(risk) premium while each claim declared will cause a 25% increase in the same. The goal here is to promote cautious drivers while making a clear distinction between good risk and bad risk by the insurance company.

1.13.1.3 Applying variables to model

To determine how the "age of policy owner" variable can best be applied to the model, first step is to deal with the age variable as a complete (without going to age grouping within) element of risk (variable) and check whether the continuous random variable sampling truly reflects the claims frequency. Continuous random (chance) variables' "probability density function" types are:

a. Exponential distribution,
b. Continuous uniform distribution,
c. Normal distribution.

Besides, when age ranges are dealt with as "discrete random variables", it can be observed how much the sampling reflects claims frequency. Probability density function of discrete random variables is here Poisson distribution and Negative Binomial distribution based on an event "coming true or not coming true" (realizing/not realizing, successful/unsuccessful, 1/0). Besides, "Geometric distribution" and "Hyper-geometric distribution" probability density functions are also functional in calculating probabilities of discrete random variables.

There are differences between state results of random variables (discrete or continuous). In a study regarding automobile claims frequency conducted at Romania Iasi University in 2015, below results were obtained: according to the statistics models applied to the claims data of a French insurance group's automobile insurance portfolio's 150.021 insurance policies between 2007-2009;

The distribution of "expected frequencies" corresponding to "age" (continuous/discrete) random variable (X) and its relevant ranges (there are more than one age group) can be observed in below given graphics (relative frequency, probability) (Resource: Data is processed with SAS 9.3).

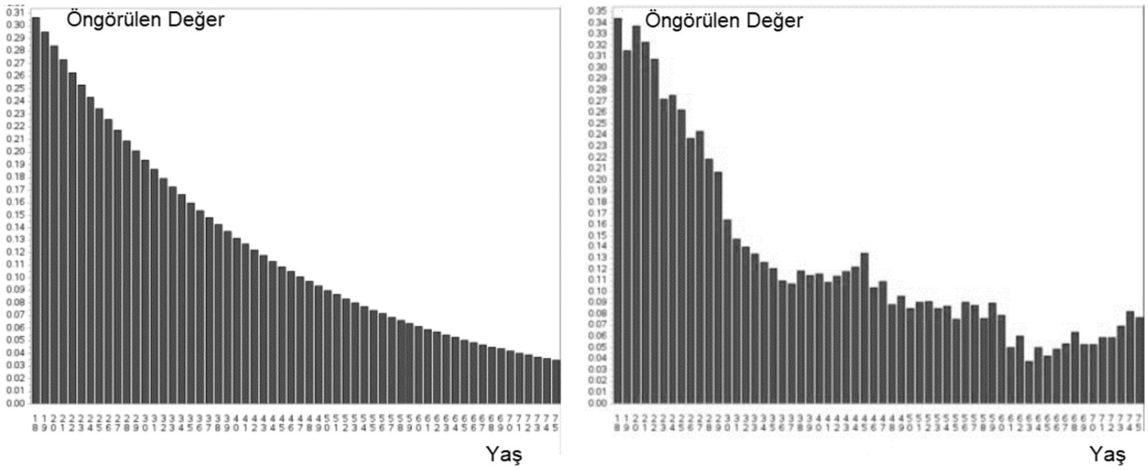


Figure 1. 3: Continuous (left) and discrete (right) age random variable frequencies.

In the first scenario, the decrease in claims frequency value as the policy owners' ages increase is remarkable. Prominent characteristics of age-related classified distribution are as following:

a. Concave status of claims frequency graphic parallel to increasing age values is significant.
b. Younger age groups have a relative higher claims frequency.
c. Claims frequency decrease in middle age values is significant.
d. In the graphic that models age as discrete random variable, claims frequency values increase in older ages.

As can be observed in the graphic in the right in (Figure 1. 3), since the difference between certain age groups can be very few, it is possible to group age variables within themselves to simplify them. Age grouping of insurance owners in graphical projection can be observed as an average portfolio in 5 risk sub-groups.

Table 1. 5: Risk groups based on age grouping.

NO	DESCRIPTION	DESCRIPTION	VALUE
1	Inexperienced	Age	18-22
2	Young	Age	23-29
3	Experienced	Age	30-60
4	Senior	Age	61-67
5	Elder	Age	68-75

Therefore, it is possible to determine homogeneous risk groups in order to determine right risk levels as a risk factor in five sub-categories of relevant discrete random variables of policy owners' ages.

1.13.1.4 Adjusting model to variables

In non-life insurances, Poisson probability dispersion model becomes very prominent when actuaries focus on predicting claims frequency. Even though Poisson model is very popular in the literature for modeling accounting data (predicting probabilities), the fact that it ignores the sampling variance exceeding groundmass average *(over dispersion)* creates a weakness in practical application: $(s^2) > (\mu)$

In general application, if the reason for over dispersion cannot be determined and/or eliminated, negative binomial models are used. At this point, functionality of NB1 and NB2 forms of negative Binomial distribution also comes to the forefront.

1.13.1.5 Poisson model

Poisson distribution is also known as "Law of Small Numbers" in literature, because it is a probability distribution (model) that can explain the occurrence number of an event at any time in addition to the wide acceptance that the distribution will be seldom.

(Cameron and Tivedi, 1998) defined the laws regarding the relatively seldom events in their studies. Authors accept that the "average occurrence number of an event" in a certain unit range is known and the time difference between an event and a following event is independent from previous time differences. In terms of actuarial literature, extensive reference regarding the

Poisson distribution, which is used as the main tool for predicting claims frequency, can be found in (Dionne and Vanasse, 1989 and 1992), (Denuit and Lang, 2004), (Gourieroux and Jasiak, 2004), and (Yip and Yau, 2005) studies.

When discrete random variable (Y_i) (claims frequency or observed claims values) is thought to have a parameter with explanatory random variables vector (X_i) (features of insurance owners), it is assumed that they are "distributed as Poisson". (Y_i)'s probability density function is:

$$f(y_i|x_i) = \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} \qquad (1.18)$$

The relation in (Equation 1.18) represents (Y_i) the probability of y_i ($y_i \in \mathbb{N}$) value to be assigned to discrete random variable (in terms of insurance owners' features).

Even though Poisson distribution is accepted as benchmark model in "non-life insurance" data, it was criticized in (McCullagh and Nelder, 1989) and (Gourieroux and Jasiak, 2001) studies for the fact that variance is not being constant *(heteroskedasticity)* due to the fact that model-conditioned average and variance's *equidispersion.* As is, Poisson distribution parameter represents both the average and the variance of the distribution at the same time (equation 1. 19).

$$E(y_i|x_i) = V(y_i|x_i) = \lambda_i \qquad (1.19)$$

Within the concept of Generalized Linear Models regarding accounting data, the average of dependent variable's average is related to the linear determinant based on the function that makes the contact. As a well-known side of Poisson distribution in literature, Poisson distribution is a "logarithmic function" – natural link function (equation 1. 20).

$$\ln(\lambda_i) = \beta_0 + \sum_{j=1}^{p} \beta_0 x_{ij} \Rightarrow \lambda_i = e^{x_i^t \beta} \qquad (1.20)$$

Predictions of parameters are made with maximum probability. To ensure that (Equation 1.18) forms the highest probability, probability function is formed as following (equation 1. 21);

$$L(\beta) = \prod_{i=1}^{n} \frac{e^{-\lambda_i}\lambda_i^{y_i}}{y_i!} = \prod_{i=1}^{n} \frac{e^{-e^{x_i^t\beta}}\left(e^{x_i^t\beta}\right)^{y_i}}{y_i!} \qquad (1.21)$$

By taking the "logarithms" of both sides of (Equation 1. 21), a *"log-likelihood"* function is obtained (equation 1. 22);

$$LL(\beta) = \sum_{i=1}^{n} [y_i ln\lambda_i - \lambda_i - ln \ \ _i] = \sum_{i=1}^{n} \left[y_i x_i^t\beta - e^{x_i^t\beta} - lny_i\right] \qquad (1.22)$$

Highest (maximum) probability (parameter) predictors ($\hat{\beta}$) as regression coefficients provide us with the solution by equalizing "log-likelihood" function to zero. Here, the equations that form this system do not provide explicit solutions so it is needed to provide a numerical solution with using a repetitive (iterative) algorithm (simulation). At this point, (Charpentier, A., and Denuit, M., 2005) stated that the most extensive repetitive algorithm methods are Newton-Raphson or Fisher information.

Even though Poisson distribution is widely used to predict claims frequency, empirical evidences in literature show that the model is generally very limiting for this kind of data. As was emphasized previously, main problem with Poisson distribution is that variance exceeds the average (overdispersion).

There may be many sources of *overdispersion* (Hilbe, 2007). A satisfactory explanation for its reasons was provided in the literature based on the difference between "apparent" and "real" overdispersion (dispersion, scattering) concepts. Accordingly, overdispersion occurs from surplus of the values that are left outside of the lower and upper limits of apparent overdispersion data set and that do not correspond with the data set when compared with other values (incompatible values) – when these values are ignored as a risk factor. Studies in this subject (Denuit et al., 2007) emphasize that the occurrence of overdispersion is caused because the reasons for "natural driving differences" between automobile insurance policy owners of insurance companies (reflex quickness of drivers, aggressiveness while driving, drug usage, etc.) cannot be observed. Since these explanations regarding the occurrence of overdispersion of data cannot provide a solution for the problem, this overdispersion phenomenon is finally accepted as *"equidispersion",* in other words, as a special type of "unobserved heterogeneity".

In literature, there are many studies that tried to test the hypothesis of overdispersion. Within this context, (Cameron and Trivedi, 1990) suggested a test for overdispersion. It is the OLS regression test without an external "expected value" (without an average), which corresponds to related sample data variables and based on output variable values predicted by the Poisson model $\widehat{\lambda_\iota} = exp(x_i^i\beta)$ (which hosts overdispersed result variables within) (equation 1. 23);

$$\frac{\left(y_i - \widehat{\lambda_\iota}\right)^2 - y_i}{\widehat{\lambda_\iota}} = \alpha \frac{g(\widehat{\lambda_\iota})}{\widehat{\lambda_\iota}} + u_i \qquad (1.23)$$

While (u_i) represents the term "error", $g(\widehat{\lambda_\iota})$'s known variable function is usually $g(\widehat{\lambda_\iota}) = \hat{\lambda}_i^2$. First function corresponds to NB2 form of negative binomial distribution while second corresponds to NB1 form of negative binomial distribution. At this stage, null hypothesis of not having an overdispersion by using *(t)* statistic for α $(H_0: \alpha = 0)$ becomes re-testable against the other hypothesis towards overdispersion $(H_1 = \alpha > 0)$.

Another practical and trustworthy test towards overdispersion is the method based on "Lagrange's Multiplier (LM)" test and that was introduced by (Greene, 2002). Accordingly, test statistics produced by the model follows (X^2) distribution with a one (1) unit degree liberty (equation: 1. 24).

$$LM = \frac{\left(\sum_{i=1}^{n} \lambda_i^2 - n\overline{y_\iota}\right)}{2\sum_{i=1}^{n} \lambda_i^2} \qquad (1.24)$$

When the value obtained from the model is compared with theoretical data, test results will become tangible and the hypothesis regarding overdispersion will be denied. This way, it can be proved that other expansions can be preferred over Poisson.

1.13.1.6 Negative binomial models

For the data sets, in which the variance is significantly greater than the average, negative binomial models are preferred as an alternative to Poisson distribution model.

Negative binomial probability density (distribution) model is functional when used as a solution for the "*equidispersion*" problem of the Poisson distribution function. In literature, there are many interpretations of negative binomial. However, according to (Boucher et al., 2008), the strongest argument regarding negative binomial is that its random heterogeneity approach that its average parameter's random heterogeneous term (θ)'s 1, and variance is (α). This approach is deeply discussed in literature by (Gourieroux et al., 1984a, 1984b), (Cameron and Trivedi, 1986, 1990, 1998), (Winkelmann, 2004) and (Greene, 2008).

The studies made with real insurance industry data underline an approach of "accident proneness theory" (Greenwood and Yule, 1920). According to this theory; accidents fit Poisson distribution but at the same time, they also include an unobserved discrete heterogeneity that makes it impossible to observe the average within its data set without errors and was distributed as gamma. In actuarial literature, problems regarding these karma models were underlined and separate studies were carried on; (McCullagh and Nelder, 1989), (Lawless, 1987), (Dionne and Vanasse, 1989), (Denuit and Lang, 2004), (Boucher et al., 2007), (Hilbe, 2014).

A traditional Negative Binomial (with two terms) distribution model was formed based on a Poisson and Gamma distributions karma *(hybrid)* model. Accordingly, variable (θ) is thought to be distributed as gamma. Accordingly, probability density distribution is (equation 1. 25);

$$f(\theta) = \frac{\Gamma(1/\alpha)^{1/\alpha}}{\Gamma(1/\alpha)} \theta^{1/\alpha - 1} \exp\left(-\frac{\theta}{\alpha}\right) \qquad (1.25)$$

In literature, negative binomial distribution model's ability to obtain results for frequency modeling of total damage distribution is widely accepted.

(McCullagh and Nelder, 1989) advocate that (Y_i) random variable is distributed as "negative binomial" under (λ_i) and $\alpha(> 0)$ parameters. Mass productive function is (equation 1. 26);

$$f(y_i, \lambda_i, \alpha) = \frac{\Gamma(y_i + \alpha^{-1})}{\Gamma(y_i + 1)\Gamma(\alpha^{-1})}\left(\frac{\alpha^{-1}}{\alpha^{-1} + \lambda_i}\right)^{\alpha^{-1}}\left(\frac{\lambda_i}{\alpha^{-1} + \lambda_i}\right)^{y_i} \qquad (1.26)$$

In (Equation 1.26), term (α) is "constant" while playing the role of "distribution factor". It is clear that when (α) approaches (0), Negative Binomial distribution's distribution shrinks when compared to Poisson model's distribution because of its relevant additional parameter (λ_i).

(Cameron and Trivedi, 1986) revealed a more extensive type of Negative Binomial (NB_p), which has the same average (λ_i) but variance of which is in $(\lambda_i + \alpha\lambda_i^p)$ structure. (Cameron and Trivedi) introduced the most well-known and most used forms of Negative Binomial. If (p) is equal to 1, then NB1 drags its distribution and when $(p = 2)$, NB2 distribution is known as – Quadratic Negative Binomial distribution. NB1 model's mass probability function is (equation 1. 27);

$$f(y_i, \lambda_i, \alpha) = \frac{\Gamma(y_i + \alpha^{-1}\lambda_i)}{\Gamma(y_i + 1)\Gamma(\alpha^{-1}\lambda_i)}(1 + \alpha)^{-\lambda_i/\alpha}(1 + \alpha^{-1})^{-y_i} \qquad (1.27)$$

NB1's first two moments are (equation 1. 28);

$$E[y_i] = \lambda_i \qquad (1.28)$$

(Equation 1. 29);

$$V[y_i] = \lambda_i + \alpha\lambda_i = \emptyset\lambda_i \qquad (1.29)$$

"*log-likelihood*" (LL) model for NB1 Model is; (equation 1. 29b);

$$LL(\alpha,\beta) = \sum_{i=1}^{n}\left\{\left(\sum_{k=0}^{y-1}(k+\alpha^{-1}\lambda_i)\right) - lny_i! - (y_i+\alpha^{-1}\lambda_i)\ln(1+\alpha) + y_i ln\alpha\right\}$$

As (Cameron and Trivedi, 1998) described, prediction based on first two (2) moments created from NB1 probability density function gives Poisson GLM predictor and it is also the predictor for NB1 GLM.

Probability mass function for NB2 coincides with general negative binominal density function. NB2's first two moments are (equation 1. 30);

$$E[y_i] = \lambda_i = e^{x_i^t\beta} \qquad (1.30)$$

(Equation 1. 31);

$$V[y_i] = \lambda_i(1+\alpha\lambda_i) \qquad (1.31)$$

"*log-likelihood*" model (LL) for NB1 Model is (Equation 1. 32);

$$LL(\alpha,\beta) = \sum_{k=1}^{n}\left\{-\log(y_i) + \sum_{k=1}^{y_i} log\,(\alpha y_i - k\alpha + 1) - (y_i+\alpha^{-1})\log(1+\alpha\lambda_i) + y_i\log(y_i)\right\} \qquad (1.32)$$

(Cameron and Trivedi, 1998) discussed the fact that (α)'s prediction was not really popular in literature. The interest usually is focused on (β_j)'s prediction (with the assumption that α is not a primary parameter). Same authors emphasize that this difference is as important as it is in predicting the standard deviation of $(\widehat{\beta}_j)$ dependent on $(\hat{\alpha})$.

(Boucher and Guillen, 2009) underline that the process of parameter predicting is almost the same in all three models. However, this is only valid when enough number of necessary conditions are provided. For NB Models, (Vasechko et al., 2009) and (Allain and Brenac, 2012) state that expected parameters $(\widehat{\beta_j})$ and predicted values $(\widehat{\lambda_i})$ have a very low deviation when compared to the results obtained from Poisson model, but the increase in error values of $(\widehat{\beta_j})$ predictor is significant. (Boucher and Guillen, 2009) examined automobile claims frequency through NB models and realized that regression coefficients do not have a significant deviation. They proposed more consistent approaches towards standard errors regarding predictions ignored in Poisson model. A similar point of view was proposed by (Hilbe, 2014). Here, the importance of variance in the fact that NB distribution has similar features with Poisson and for the solution towards the approach regarding the average being the same in both was emphasized.

1.13.1.7 Deciding on the most suitable distribution model

In literature, there are many statistical methods towards evaluating the performance of accounting data models and choosing the most suitable distribution. As argued in (Denuit and Lang, 2004)'s studies, there is a model that comes to the forefront among many models towards the suitableness of data: the method, which follows the probability rate's $(x^2_{\alpha,b})$ distribution on *(0.05 ∝)* significance level and *(p)* liberty degree and that reveals *(p)'s* explanatory variables' number. This statistic was obtained from the deviation of the regression model without predicted variable (D_0) and the model's deviation also includes the independent variables (D_p);

$$LR = D_0 - D_p \qquad (1.33)$$

$$D = 2\left(LL(y_i|y_i) - LL(\lambda_i|y_i)\right) \qquad (1.34)$$

$$LR = -2\left(LL_p - LL_{NB}\right) \qquad (1.35)$$

(Charpentier and Denuit, 2005) defined the deviation between the accessible maximum log-likelihood model $(y_i = \lambda_i)$ and the log-likelihood models that corresponds to data twice (2).

Probability rate representing a value greater than statistics theoretical value $(LR > x^2_{\alpha,p})$ shows that the regression model explains the applied (analyzed) value well.

1.13.1.8 Conclusion

A system ensuring the accurate calculation of net (risk) premium also ensures that an insurance company can meet the expected damages and make a balanced separation of precautionary provisions. First stage of automobile insurance pricing is to model claims frequency, which is also the foundation for creating a reasonable and fair profitable insurance premium.

In this part of this thesis, the use of classical and hybrid accounting data models in predicting automobile claims frequency is handled in a way to explain the risk insured by focusing on risk factors. The solution it has towards overdispersed data and various studies regarding automobile insurance claims frequency in literature show that NB model is more suitable for the data when compared to the Poisson model. Again, many studies in literature, which are also referenced in this study, show that among NB1 and NB2 forms of Negative Binomial model, NB2 is usually predominant in accuracy. To overcome the overdispersion occurring in Poisson model results is crucial for accurate prediction of automobile claims frequency.

According to some prominent aspects of the common grounds of studies in literature, “age group”, “profession”, “vehicle type”, “GPS usage”, “bonus-malus system” and “duration of insurance period” are explanatory risk factors when explaining claims frequency. The duration of insurance period decreases claims frequency while no claims bonus works the same way. On the other hand, profession of insurance owners and use of GPS are also prominent factors in explaining claims frequency while the value of the vehicle is not explanatory enough. In light of these data, it is possible for insurance companies to differentiate average risks groups based on portfolio and create a fairer premium (price) production.

1.14 Claim and Claim Reserves

Claims (Damages): The damage (loss) arising from the realization of any of the securities of the policy (risks).

Policy Reserves: Claims (damages) happened within the activity period but indemnity payments of which are still not paid (due to expertise, formality period, disagreements, etc.).

As a result, the fact that a claim took place creates the possibility for an indemnity payment. Therefore, this necessitates the preservation of a required amount in case of possible payments (precaution principle). Right and accurate prediction of claims is a catalyst for an accurate premium pricing in addition to being extremely important for critical business decisions.

Not being able to accurately predict policy reserves may cause an inability in meeting the claims, loss of capital and even the likelihood of bankruptcy.

Within this context, "Technical Reserves" are the most prominent item in insurance companies' financial statements. Policy Reserves constitute the 4^{th} reserve group along with premium, mathematical and equalization reserves.

While predicting these reserves, it is important to consider claims frequency, amount of claims (severity) and all other factors including the development pattern of the claim (Karacan, 1994).

Total policy reserves are;

a. Accrued but not paid policy reserves (known claims).
b. Realized but not declared policy reserves (IBNR).
c. Policy reserves provisions.

1.15 Claim and Premium Relation

Insurance companies have to maintain a balance between the premium they collect and the indemnity payment they pay in case of a claim. Therefore, it is essential to have a fair premium pricing and have a claims rate close to sample mass rate by increasing the risk numbers they secure by "the Law of Large Numbers", which is one of the main principles of insurance business (Akmut, 1980).

Insurance companies observe the balance between claims and premiums from "claims/preium rate". This rate shows the ability of premiums meeting claims.

Claims that insurance companies are and will be exposed to are tracked by two variables and explained by the distribution function of these variables. Related variables are "claims frequency" (claims number, frequency) and "claims severity" (greatness and extent of claims).

"Total policy reserves" should be enough to meet all expected claims.

1.16 Claim Development and Claim Development Coefficients

The development of the total payment in a certain period for a certain group of claims file is called "paid claims development". Claims Development are expressed with "Claims Development Coefficients" (Sigma, 2000).

For example, arithmetically, claims development coefficient paid annually in year *(T)* is the proportion of cumulative payment in year *(T)* to the cumulative payment in year *(T-1).*

Based on paid claims development coefficients, there are also "realized claims development coefficients". If claims file predictions are preservative, realized claims development coefficient is expected to be less than 1. Realized claims development coefficients greater than 1 either indicate that the predictions are insufficient or the existence of external circumstances such as late reporting.

To observe claims development, obtained data are grouped on a triangle chart. In "data triangles", lines indicate dates while columns indicate periods following the dates. Triangle charts can be regulated according to year of claims (year of the event), year of the policy (year of underwriting) or the year of declaration.

Parameter systematics to be used in data triangles are:

(İ) Basal date of the claim, 0,…,n , *(J) Period of time following the basal date, (J)* 0,…,n , *(N) Number of periods observed,* $(S_{i,j})$ realized in i. period of time and number of claims paid in *(i+j)* period (not cumulative), $(C_{i,j})$ cumulative claims amount realized in i. period of time and observed after j periods.

$S_{i,j} = C_{i,j} - C_{i,j-1}$

1.17 Claim Reserves

After creating periodical claims payments data and after that creating its cumulative claims payments structure, it is necessary to find development coefficients to see the claims payments development.

In "Chain Ladder Method", each period's "claims development coefficient" is obtained by dividing the cumulative claims payments in each period by the cumulative claims payments in the previous period. The average of development coefficients in each line is taken and an "average development coefficient" is obtained for each related period. Methods like arithmetical average, geometric average, average of last 3 years, volume weighted average etc. can be used to obtain average development coefficients. Development coefficients are used to predict the empty parts of data triangles.

Fast Track Reserves: In insurance branches with high frequency and fast processes, like automobile accidents, an average prediction is made based on past experiences.

Below-given information can be found in claim files constituting claim data:

a. Insurance branch (residence, fire, etc.)
b. Damage occurrence date
c. Date of notice (date the insurer was notified)
d. Policy regulation date
e. Policy number
f. Claim number
g. Partial payments
h. Other data that may be dependent on claims

1.17.1 Content of claim reserves (case total / case reserves)

First prediction for policy reserve is the sum of all individual predictions for all open files. In this method, claims are processed as they are realized. As the information on claims are updated, they are reflected on calculations.

Besides, for gross IBNR reserve, below-given items should also be predicted (Goovaerts and Hendrick, 1999).

a. Future amendments of file reserves.
b. Files that are closed but may be re-opened.
c. IBNR *(incurred but not reported)*.
d. RBNR *(reported but not recorded)*.

1.18 Chain Ladder Method / Claim Triangles (Chain ladder method)

In insurance industry, many forms of "Chain Ladder Method – Claim Triangles" are used to predict claim reserves in actuary departments. Claim Development Triangle is one of them.

Chain ladder method is realized with below-given steps (Friedland, 2009).

a. Creating a development triangle with claim data
b. Calculating development coefficient per year
c. Taking the average of development coefficients per year
d. Choosing development coefficients
e. Following up with development coefficients
f. Finding cumulative claim development coefficients
g. Final claim prediction

In claim prediction process, reported and paid claims data are also used along with claims frequency data. Chain ladder method is used in all insurance branches.

It also includes the branches with claims that are reported and paid long after occurrence date in addition to claims that are reported and paid soon after occurrence date.

Various dates can be taken as basis while developing claims data (year of the event, year of the policy, year of reporting, year of regulation, etc.). Triangles can be created both for paid claims and realized claims payments.

In the sample, a chart regarding “paid claims” lists payments in the previous years for a certain insurance branch. Inputs in *(i)* year of the claim and *(j)* year of development express the paid claims in the calendar year *(j)* for a damage happened in *(i)* basal year. *(j=0)* represents the payment in relevant basal year, *(j=x)* represents oncoming development (payment) years. In the sample, all these calculations are made by assuming that all payments for each damage year was made (completed) by the end of 7^{th} development year for a maximum. Amounts in column 0 always show “amount of claims happened in the related period and paid within the same period (fastest payments)”. Values in column 1 show the amount of claims “paid within the 1^{st} period following the occurrence of the claim”.

Upper triangle of the chart shows the claims payments made in and before *(i=8)* year. Lower triangle of the chart includes the claims amount predicted for the future based on “average development coefficients”.

Chain Ladder Method has 3 steps to develop policy reserves. First step is to model claims development for each year column based on obtained data history *(development factor)*. This way, the model can be used to predict expected payments for each claim year. Finally, the amount of reserve to be kept can be obtained by deducting made payments from expected payments.

Preview in (Chart 1.18) was prepared from true “paid claims” data. However, it is also possible to process “claims that are realized but not yet paid” (claims in “pending” status) in the same sense. Actuaries generally create triangles both for paid claims and realized claims payments.

It represents the approximate claim amount that is realized, known by the insurance company and has the possibility to become a payment but not yet paid. The amount reserved for a possible payment based on the sum of pending claims by the end of the financial year is called pending policy reserve.

Table 1.6: Chain Ladder (paid claims) method sample.

"i"	j = 0	j = 1	j = 2	j = 3	j = 4	j = 5	j = 6	j = 7	$\sum X$
i = 1	5,000	4,000	3,000	2,000	1,000	500	250	125	15,875
i = 2	6,000	5,000	4,000	3,000	2,000	1,000	500		21,500
i = 3	7,000	6,000	5,000	4,000	3,000	2,000			27,000
i = 4	8,000	7,000	6,000	5,000	4,000				30,000
i = 5	9,000	8,000	7,000	6,000					30,000
i = 6	10,000	9,000	6,000						25,000
i = 7	11,000	10,000							21,000
i = 8	12,000								12,000
									182,375

"i"	j = 0	j = 1	j = 2	j = 3	j = 4	j = 5	j = 6	j = 7	$\sum X$
i = 1	5,000	9,000	12,000	14,000	15,000	15,500	15,750	15,875	15,875
i = 2	6,000	11,000	15,000	18,000	20,000	21,000	21,500		21,500
i = 3	7,000	13,000	18,000	22,000	25,000	27,000			27,000
i = 4	8,000	15,000	21,000	26,000	30,000				30,000
i = 5	9,000	17,000	24,000	30,000					30,000
i = 6	10,000	19,000	25,000						25,000
i = 7	11,000	21,000							21,000
i = 8	12,000								12,000
									182,375
	12,000	21,000	25,000	30,000	30,000	27,000	21,500	15,875	182,375

"i"	$j_{1,0}$	$j_{2,1}$	$j_{3,2}$	$j_{4,3}$	$j_{5,4}$	$j_{6,5}$	$j_{7,6}$
i = 1	1.8000	1.3333	1.1667	1.0714	1.0333	1.0161	1.0079
i = 2	1.8333	1.3636	1.2000	1.1111	1.0500	1.0238	
i = 3	1.8571	1.3846	1.2222	1.1364	1.0800		
i = 4	1.8750	1.4000	1.2381	1.1538			
i = 5	1.8889	1.4118	1.2500				
i = 6	1.9000	1.3158					
i = 7	1.9091						
i = 8							
Ortalama HGK	1.866	1.368	1.215	1.118	1.054	1.020	1.008

	j = 1	j = 2	j = 3	j = 4	j = 5	j = 6	j = 7	Forecast Claims	Claim Payments	Forecasr Claims Reserve
i = 1								15,875	15,875	0
i = 2							21,671	21,671	21,500	171
i = 3						27,539	27,758	27,758	27,000	758
i = 4					31,633	32,265	32,521	32,521	30,000	2,521
i = 5				33,546	35,372	36,078	36,365	36,365	30,000	6,365
i = 6			30,385	33,976	35,826	36,541	36,831	36,831	25,000	11,831
i = 7		28,732	34,921	39,048	41,174	41,996	42,329	42,329	21,000	21,329
i = 8	22,394	30,640	37,240	41,641	43,908	44,785	45,140	45,140	12,000	33,140
	22,394	59,372	102,545	148,211	187,913	219,205	242,615	258,490	182,375	76,115
	21,000	25,000	30,000	30,000	27,000	21,500	15,875			
	43,394	84,372	132,545	178,211	214,913	240,705	258,490			

i = 8	j = 1	j = 2	j = 3	j = 4	j = 5	j = 6	j = 7	Periods (Quarterly / Yearly)
Dönemsel	22,394	36,977	43,173	45,665	39,703	31,292	23,410	

1.19 Probability Distribution, Chain Ladder and Claim Reserves Relation

Chain Ladder is an observation and calculation model named by its shape. Just like there are many methods used to calculate development coefficients, there are also many techniques used in literature to maximize chain ladder method's accuracy.

A few examples that may be used in combination with Chain Ladder method are "Probable Claims", "Bornhuetter-Ferguson" and "Claims Frequency and Claims Severity" methods.

At this point, since we mentioned "Probability Distributions" at the beginning of this study, we should also mention "claims frequency and claims severity" concepts.

Claims frequency include claims with high frequency but low severity, such as traffic accidents or burglary in near-by apartments. Natural disaster insurances on the other hand are low frequency but high severity claims (Milli Reasürans, 20014). There is an inverse proportion between claims frequency and claims severity.

Policy reserve analysis generally depends on two development triangles; one of them is realized claims number (number of reported claims) while the other is average payment for each realized payment triangle (Brown and Gottlieb 2001).

The model also provides "claims frequency" information from data entered according to realized claims payment (known) periods (number and amount) and accurate "average claim severity" information from claim payments.

For example, let's say that cumulative claims payments details during development years are definite. Besides, let's assume that total number of closed claims for each event year is known. Definite closed claims number for each event year can be "predicted" from realized claims amount triangle. When the total amount of paid claims is divided by total closed claims for each period, claims triangle will be calculated. This way, data of cumulative average claims severity throughout development years is obtained.

After this point, predicted definite claims payment amount for each claim can be calculated again with chain-ladder method. For each event year, predicted (from average coefficients) definite claims number is multiplies with closed average claims severity and the final claim for relevant period is predicted (Cuma Yılmaz, 2009).

After this level, the model uses the data entered according to realized payment periods. Claim amounts from earliest paid to last paid are subjected to a "regression analysis". After function type is defined, “original data” showing “excess deviation” when compared to the standard deviation of calculated (predicted) data can be “amended” to be reformed to be acceptable. Cumulative policy reserves are calculated again with amended “paid claim” values within chain-ladder method.

2. EXCHANGE RATE and INFLATION DYNAMICS

2.1 Chapter Plan

"Exchange rate pass-through", which is the 'main subject' of this study, is, by definition, the change of prices of goods and services subject to foreign trade in terms of exchange rate in domestic markets due to the changes in foreign exchange rates. Within this context, it is necessary to first define the factors that may cause a change in foreign exchange rates. This chapter of this study will examine the factors that define and effect "exchange rates".

Purchasing Power Parity (PPP) approach, which is one of the hypotheses that form the foundation of exchange rate determination models, will be examined in detail.

2.2 Exchange Rate Regime Preference

Exchange rate regime (exchange rate determination model) preference is important in terms of it being used as a tool to overcome macroeconomic problems and to ensure integration with global economy for developing countries (Uçan, 2014).

Exchange rate regime preference has a strategic importance to minimize the effects of exchange rate fluctuations caused by macroeconomic shocks in addition to its roles regarding related money and finance policies.

Since 1980's, we have been experiencing a "fixed exchange rate regime". In the earlier times, the exchange rate was fixed on gold. However, in our modern day, the exchange rate is indexed to a country's currency and certain limited fluctuations are allowed.

In "Floating Rate Regime", exchange rate is left for the free market to determine. It fluctuates in accordance with supply and demand just like commodities or merchandise.

Today, we use hybrid systems created from these two systems because in the financial market circumstances, in which globalization comes to the foreground, interventions from central banks do not give an opportunity to apply "pure floating rage regimes".

2.3 Reel Exchange Rate, Purchasing Power Parity and Balassa-Samuelson Model

In the developing countries and especially in Turkey, where the applied exchange rate regime is crucial, it is very important to focus on exchange rate – detection – regime while talking about inflationist effects of exchange rate and exchange rate shocks.

Before moving on to *Purchasing power parity – PPP*, we should focus on the concept of "price" in its most basic form based on "exchange rate price"; in an exchange economy according to "Distribution of Income Theory", "price" is the "objective exchange value" of a commodity in exchange of another commodity. Instead of "exchanging a commodity with another commodity", this exchange happens with and is paid for with money in a "money economy". Therefore, "price" is defined as "the exchange rate of a good or service with another good or service". When defined in terms of international trade, it defined the exchange prices of goods subject to foreign trade in terms of the change rate in the currencies of relevant countries.

Exchange rate is "relative" prices of two countries' currencies. In other words, it is the amount of money that needs to be paid in order to obtain one unit of foreign currency. "Real exchange rate" is adjusting or fixing nominal (apparent/written) exchange rate with price levels. The relationship between nominal exchange rate and relative price levels is:

$$e = q + (P + P^{*}) \qquad (2.1)$$

In the afore-given equation showing "relative purchasing power parity", *(e)* and *(q)* represent proportional change in "nominal" and "reel" exchange rate respectively while *(P)* and *(P*)* represent proportional change in domestic – international price levels. Accordingly, the difference that occurs between the proportional changes of price levels of countries in time equals the change in exchange rate. Within this concept, when domestic price levels are higher than international price levels, the exchange rate will increase as much as the difference between the first and the latter.

To detect the determining factors of real exchange rate, it is assumed that price indexes are the average of prices of tradable and non-tradable goods.

$$P_t = \alpha P_t^N + (1-\alpha)P_t^T \quad (2.2)$$

$$P_t^{T*} = \alpha^* P_t^{N*} + (1-\alpha)P_t^{T*} \quad (2.3)$$

While small letters represent logarithmic values, the * represents foreign country, (N) represents non-tradable goods and (T) represents tradable goods.

$$q_t = (e_t - P_t^T + P_t^{T*}) - \alpha(P_t^N - P_t^T) + \alpha^*(P_t^{N*} - P_t^{T*}) \quad (2.4)$$

$$q = (e_t - P_t^T + P_t^{T*}) - \propto (P_t^N - P_t^T) \quad (2.5)$$

The equation above explains three components of real exchange rate:

a. Relative prices of tradable goods.
b. Relative prices of non-tradable goods in terms of tradable goods.
c. Relative prices corresponding to the goods in foreign country.

In this approach, which is also known as "Balassa-Samuelson model", exchange rate is dependent on the "relevant internal prices" non-tradable and tradable goods. If the productivity regarding tradable goods is high in a country, prices of non-tradable goods will increase faster than tradable goods. The reason for this is the assumption that together with increasing productivity, prices in tradable goods industries will also increase and this will reflect on non-tradable goods industry and will eventually cause an increase in prices. Therefore, this will cause an increase in value of real exchange rate in economy. This means that the price increase in non-tradable industries will cause a general increase in price levels and eventually an increase in value of real exchange rate (Giancarlo, 2001).

2.3.1 Basic Assumptions forming the basis of Exchange Rate Determination Models

Three fundamental assumptions that form the basis of explanatory models of exchange rate changes are:

1. Purchasing Power Parity (PPP). (A single model on its own)
2. Efficient Markets PPP (EMPPP).
3. Interest rate parity.

2.3.1.1 Purchasing power parity - PPP

Purchasing power parity was first used to calculate real exchange rate by Wheatley in 1803. It was later developed by economist Gustav Cassel in the article he published in 1918.

The ratio that equalizes the purchasing powers of different currencies by resetting price differences between the countries with a foreign trade relationship with one another is called "Purchasing Power Parity (PPP)". In theory, countries' purchasing powers are determined in accordance with their price levels. It is possible to buy equal amounts of goods and services with equal amounts of different currencies. It means the equality between two countries' exchange rates with their price levels (Akgül, 1995).

"Law of one price" explains that – theoretically under the assumption that there are no cost elements like transportation, commission, etc. – when the same goods sold in different countries are expressed in a single currency, they need to be sold for the same price (same value) (Copeland, 2005).

PPP is calculated as the ratio of national currency required to buy a product. As a value that equalizes the prices of the same goods and services groups in different countries based on comparative prices, PPP is applied as the ratio between two goods or services with the same definition to each other. Through PPP, the amount of money required buy a single good is converted into different currencies and a meaningful price for international trade is obtained.

<u>Absolute Purchasing Power Parity:</u> It is the nominal exchange rate that evaluates the ratio of Country A's (domestic) currency to Country B's (international) currency. Long-term balance value of this currency *(S)* equals to the relative proportion of Country A's price level *(P)* to Country B's price level *(P*)*;

$$S = \frac{P}{P^*} \tag{2.6}$$

$$P = S * P^* \tag{2.7}$$

Arbitrage opportunity will be possible until the equation above is equalized. If;

$$P < S * P^* \tag{2.8}$$

Then the arbitrager will buy the goods for (P) price in the country, sell the goods from (P^*) price in the international market and sell the currency he obtained from $(S * P^*)$ value in the country. This loop, also known as arbitrage, will continue until $(P = S * P^*)$ equalization is obtained.

Example: It is assumed that the purchasing price of a good in Europe is equal to the purchasing price of the same good in Turkey. While the production of said good is 1 Euro in Europe, if it's production costs 2 TRY in Turkey, the exchange rate that equalizes the purchasing price of this good will be TRY/EUR= 2.

Relative Purchasing Power Parity: It represents that the percentage of change rate in the currency in a given period of time equals the difference between general change percentage in the price levels of two countries;

$$\Delta s = \Delta p - \Delta p^* = \pi - \pi^* \tag{2.9}$$

In the equation given above, (Δs) represents the percentage change in exchange rate while *(π)* represents the inflation for Country A and (π^*) represents the inflation rate of Country B (Isard, 1995).

2.3.1.2 Purchasing power parity: level and growth concept

In level concept, the forecasting of the price level of A country depending on the exchange rate and price level of B country or the forecasting of the exchange rate depending on two price level are made. In growth concept, when the exchange rate and price level growth rate information and inflation rate forecasting of B country or the inflation rate of two countries are data, the forecasting of the exchange rate growth rate is come into question.

In order to reach to Relative PPP from Absolute PPP mathematically;

$$S_t = \frac{P_t}{P_t^*} \tag{2.10}$$

$$S_{t-1} = \frac{P_{t-1}}{P_{t-1}^*} \tag{2.11}$$

In the event that the values are divided into each other in above equation and subtracted one from both sides of the equity; is reached to following equation

$$\frac{S_t - S_{t-1}}{S_t} = \frac{\frac{P_t}{P_{t-1}}}{\frac{P_t^*}{P_{t-1}^*}} - 1 \qquad (2.12)$$

If the inflation rate;

$$\pi = \frac{P_t - P_{t-1}}{P_{t-1}} \qquad (2.13)$$

It is,

$$\frac{S_t - S_{t-1}}{S_t} = \frac{\pi - \pi^*}{1 + \pi^*} \qquad (2.14)$$

$$\frac{S_t - S_{t-1}}{S_t} \cong \pi - \pi^* \qquad (2.15)$$

2.3.2 Purchasing power parity and exchange rate relation

While the "Exchange rate" shows the exchange rate amount which a currency can purchase in another currency, PPP also shows goods or service which it can purchase. The definitions of PPP and exchange rate should not be confused with each other. While PPP express a basket of a defined goods and service, it is rate which zeroizes price differences among the countries and converts money to each other. The PPP is not for only one product, also covers goods and service groups in the market.

Within this context, this "real parity (real value equivalent)" between two countries should be expressed with the rate between purchasing power of two countries for all times.

The variable based on PPP which uses in international comparisons is Gross Domestic Product (GDP) underlying the economic activities of the countries. The GDP is the sum of goods and services produced or consumed in a country during a certain year. The GDP obtained with expenditure method in PPP calculations is taken as a basis.

In PPP, the nominal (apparent, written) exchange rate is not used and instead of it the real exchange rates are used. Due to the inflation rate will differ among countries, the corrections are made. In countries that the rate of increase in general level of the prices – inflation are high, when the exchange rate is also increased because of direct relationship between the inflation and exchange rate, in countries where it is low, the exchange rate is fallen.

$$\frac{(E_1 - E_0)}{E_0} = (P - P_f) \qquad (2.16)$$

In equation,(E_0) is expressed first period exchange rate, (E_1) next period exchange rate, (P) change in domestic prices and (P_f) change in foreign currency.

Theoretically, even if the inflation and exchange rate move in the same direction, practically, the discrepancy occurs between nominal exchange rates and real exchange rates if the Central Banks intervene to the markets. For example, when the exchange rate is pressed with the pressure of the Central Bank, the local currency is over normal, i.e. it becomes overvalued. The real exchange rates can be remained lower than the nominal exchange rates due to overvalued local currency.

Nowadays, the Central banks use the floating exchange rate regime. The local currency increases in value against currency of some countries and decrease in value according to currency of some countries in accordance with the floating exchange rate structure. In this case, the foreign currency is considered in direct proportion to the commercial and financial relations with that country for an efficient parity (value equity) calculation. The exchange rate found by making this kind of calculation is called as “efficient exchange rate”. In the flexible exchange rate systems, theoretically, the validity of long term purchasing power parity approach is essential (Şişman, 2003). If the real exchange rates are acted in compliance with PPP theory, the variations in nominal exchange rates should not affect the international competitive power.

2.4 Effective Market View

The approach based on association the “Balance of payments” of Purchasing Power Parity – PPP from basic common assumptions underlying models directed to explanation of the exchange rate variations with “Capital Account” is “Efficient market purchasing power parity

(Efficient markets view of PPP - EMPPP)". The approach emphasized that the deviations from purchasing power parity exhibits random walk in the point which is based on (Roll, 1979) and (Adler and Lehman, 1983) originally and the international financial market is efficient is called "Exante PPP" or "Efficient market purchasing power parity (EMPPP)" (Sarno and Taylor, 2002).

The gain of exchange rate change obtained by holding country money instead of B country money can be balanced with opportunity cost (interest rate difference) of funds holding in currency of A country instead of B country. This is called as "Uncovered interest rate parity condition" (Sarno and Taylor, 2002).

$$\Delta s_{t+1}^{e} = i_t - i_t^{*} \qquad (2.17)$$

The (Equation 2. 17) is "Uncovered interest rate parity – UIP condition. In this approach, a model with two countries is come into question and each country has issued perfect substitute bonds to other country money. The nominal interest rate in (Equation 2. 17) is decomposed to real and expected components with "Fischer decomposition";

$$i_t = r + \Delta p_{t+1}^{e} \qquad (2.18)$$

$$i_t^{*} = r^{*} + \Delta p_{t+1}^{e^{*}} \qquad (2.19)$$

The real interest rates of A and B countries in the (Equations 2. 18 and 2. 19) are fixed. If these two equations are put in their places in the (equation 2. 17, the (equation 2. 20) is obtained;

$$\Delta s_{t+1}^{e} = (r - r^{*}) + (\Delta p^{e} - \Delta p^{e^{*}})_{t+1} \qquad (2.20)$$

The (equation 2.21) similar to relative PPP, however its variables reflect to expected values is obtained in case of the equalization of the real interest in order to simplify. The "EMPPP" view is created under the assumption that the expectations are rational;

$$\Delta s_{t+1}^{e} = (\Delta p^{e} - \Delta p^{e^{*}})_{t+1} \qquad (2.21)$$

The exchange rate and price level formulas;

$$\Delta s_{t+1} = \Delta s^{e}_{t+1} + \varepsilon_{t+1} \qquad (2.22)$$

$$\Delta p_{t+1} = \Delta p^{e}_{t+1} + v_{t+1} \qquad (2.23)$$

$$\Delta p^{*}_{t+1} = \Delta p^{e^{*}}_{t+1} + v^{*}{}_{t+1} \qquad (2.24)$$

The last terms of Equations (2.22, 2.23 and 2.24) are random variables distributed independently. If these equations are written into the equity (in the equation 2. 21);

$$\Delta s_{t+1} - \Delta p_{t+1} + \Delta p^{*}_{t+1} = \gamma_{t+1} \qquad (2.25)$$

The (Equation 2. 25) is obtained. According to this, the real exchange rate is included first rank unit root. The stochastic "Random walk" is followed the real exchange rate. In other words, the best forecasting of the real exchange rate in any future period is the real exchange rate of today. The variation will be continuous after any event which will deviate nominal exchange rate from PPP and the new balance PPP rate will be created.

Here, the (equation 2.26 and 2.27) is written as ($\gamma_{t+1} = \varepsilon_{t+1} - v_{t+1} + v^{*}_{t+1}$) or *(q)* real exchange rate($q = S - P - P^{*}$);

$$\Delta q_{t+1} = \gamma_{t+1} \qquad (2.26)$$

$$q_{t+1} = q_t + \gamma_{t+1} \qquad (2.27)$$

The nominal exchange rate can deviate from PPP in short term, however it will return to PPP in long term. In other words, the real exchange rate will return to the average.

2.5 Interest Rate Parity

The interest rate parity which is the basic assumptions of the determination of the exchange rate models is established a connection between the exchange rates and interest rates over financial markets, such as creation of relationship between exchange rate and prices in PPP over product market. In other words, the "Law of one price" has been applied to money markets here (Levi, 2005).

It is described the theoretical relationship between A and B Countries interest rates and spot and forward exchange rates. On one hand, when the interest rate between A and B countries create interest arbitrage opportunity, on the other hand it creates the relationship between spot and forward interest rates. According to this, the relative difference (positive or negative) between spot and forward exchange rates depends on the difference between A and B countries.

The money of the A country having low interest rate earns premium as much as this difference in the forward market than the money of B country having higher interest rate. The money of B country having high interest rate is reduced (reduction) in the same amount. The theory emphasizes that there is sufficient arbitrage opportunity for equalization real interest rates between the countries in long term (Feenstra and Taylor, 2008).

The situation that the forward discount rate of the national money equals to interest difference in favour of the country is called as "Interest parity". The forward exchange rate created premium or discount in interest difference rate is called as "Interest parity rate" (Seyidoğlu, 2003).

Covered interest rate parity: According to the covered interest rate approach, for example, the interest rate of A country should be high or low as much as forward discount (premium) rate of A country money than the interest rate of B country (Copeland, 2005).

This approach is based on the assumption for example, that deposit return of rate of country money should be equal to the deposit return of rate of B country. In other words, the interest rate in A country is equal to the sum of interest rate and forward exchange rate of B country. According to this, the capital movements assume the interest rate equity for comparable assets in common currency type. The only variable caused to deviations from the parity is political risk premium (Taylor, 1986; Krugman & Obtsfeld, 1994).

The covered interest rate parity approach is described with the relationship between spot and forward rates and interest rates in open economy macroeconomic models. When the covered interest rate parity is in *(t)* period, "the exchange rate risk" is come into question due to forward exchange rate is known for *(t+1)* being next period. The exchange rate risk is existed due to that the country moneys are not perfect substitute and autonomous risks which they carry. For example, the investors of A country request an additional risk premium to hold (carry) money of B country in order to avoid from this risk (Kaya, 1998).

$$f_t - s_t = \alpha + \beta(i_t - i_t^*) + \varepsilon_t \qquad (2.28)$$

The equation is “Covered (implicit) interest rate parity – CIP” and shown the Covered interest rate parity –CIP condition. (f_t) forward exchange rate, (s_t) spot exchange rate, (i_t) and (i_t^*) are interest rates of the A and B countries respectively. Although there is no transaction cost, when *(α)* and *(β)* are at zero and different than one respectively in order to provide equation, the term of error should be free from autocorrelation issue (Hallwood & McDonald, 2000).

Due to the profitable deviations from covered interest difference in the manner different than zero will create “riskless arbitrage” opportunity, the “inefficient market” situation will come into question. When acts from assumption that the “efficient market” conditions, price include all information and being the market which it reflects, the market players cannot earn abnormal profits with the existing information. Thus, the optimal distributions of the sources are guaranteed (Fama, 1970).

The variation rate expected for exchange rate has an effect on the interest likewise “Expected inflation rate theory”. There is more than one interest rate according to the risk level, late interest and investment areas. Since the covered interest rate parity establishes a connection between exchange rate and finance market, it is useful being this parity as assumption in many theoretical models.

Uncovered interest rate parity: It establishes a connection between expected variation of the spot exchange rates and interest rate spreads of two countries (Wang, 2005). For example, the interest rate of A country should be higher (or lower) than the interest rate of B country as much as the expected depreciation (or appreciation) of A country money (Copeland, 2005).

$$E_t(\Delta s_{t+k}) = i_t - i_t^* \qquad 2.29$$

The equation expresses the covered interest rate parity and (E_t) expected value operator, (s_t) spot exchange rate, (i_t) and (i_t^*) A (domestic) and B (foreign) country interest rates respectively.

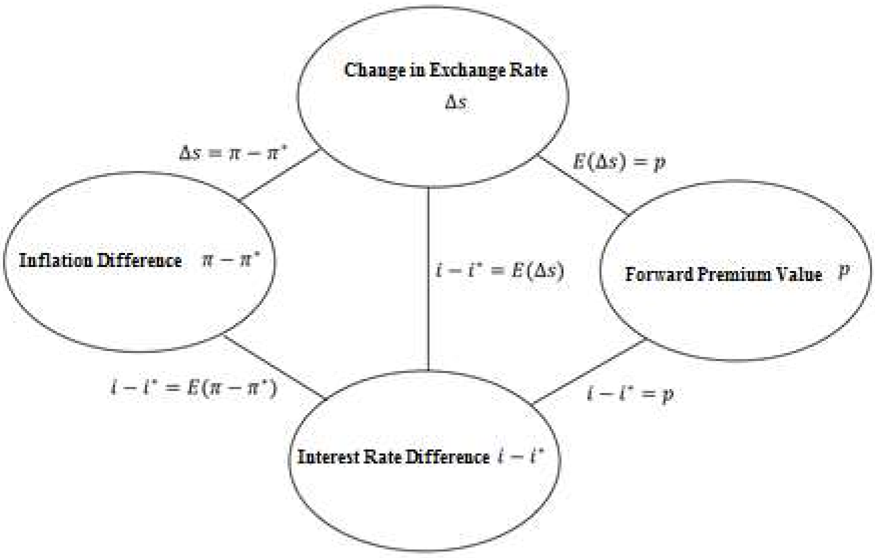


Figure 2. 1 : Interest Rate Parity

2.6 Determination of Other Exchange Rate Models and Its Assumptions

In addition to basic models and assumptions related to the determination of exchange rate being addressed up to here, the theories listed below for information purpose and as summary shed light on exchange rate generation fact;

Harrod-Balassa-Samuelson effect: It reflects the relationship between production difference and exchange rates.

Balance of Payments Approach: It defends that the exchange rates reach to balance value in case of the inflow or outflow of foreign currency and the inflow or outflow of foreign currency resulting from capital transactions balance each other.

Capital Flows Approach: The capital flows are determinant of exchange rate movements, because it suppresses effect of trade flows.

Modern Asset Approach: These new approaches address that the exchange rate balance supply and demands of the financial asset stocks over foreign currency.

Monetary Approach: It focuses on the money market and specifies that the relationships between money supply and money demand causes to exchange rate variation.

Hooper-Morton Real Exchange Rate Model: It has included the current account balance to the monetary model.

Portfolio Balance Approach: The exchange rate is determined according to the supply of relative money and financial assets.

Money Substitute Approach: It is acted over the assumption that the economic units hold portfolio baskets diversified with different foreign currencies in order to minimise the exchange rate risk.

Mundell-Fleming Model: It is associated a Keynesian model including product market and money market and net international capital flow assumptions based on the domestic interest rates.

2.7 Exchange Rate Volatility

Since the exchange rate is the price of the foreign currency, it responds to positive – negative news coming to the market immediately and has high volatility. This volatility is immediate variations occurred in a short period. Also, the exchange rate volatility can be called as the risk occurring in the exchange rate based on the unexpected movements.

The unexpected and immediate fluctuations in the exchange rate reflecting the price of the international trade goods affect the countries having outward economy, especially the developing countries negatively (Obstfeld, Cooper and Krugman, 1985; Devereux, 1997). The most important factors creating the exchange rate and exchange rate volatility;

1. Variation in the expectations.
2. Variation in the inflation rate.
3. Variation in the interest rates.
4. Speculative attacks.
5. Macroeconomic shocks.

2.8 Inflation

The inflation expresses continuous and significant upward trend occurring "general level of the prices" generated if the price stationarity being main target of the economies and central banks. The dictionary meaning in Latin is rising. It is described the increase of weighted average of all prices in the market with the general level of price expression. The variation in the relative prices, i.e. when increasing the price of a goods, it is not decreased the price of another goods relatively. Here, the generally accepted view is rate of increase between %2 - %4 annually which is valid for the developed countries as reasonable level (Karluk, 2002).

The traditional ecole directed to explain causality of the inflation emphasises on 3 basic explanatory variables. These are;

a. Monetary expansion.
b. Financial imbalance.
c. Cost-push factors.

When the classical and monetarist economists argue the increase in money amount as main reason, Keysenian perspectives is thought that the inflation is arised as an overplus in total demand according to the total supply in full employment environment.

As a result meaning, the inflation is decrease of "purchasing power of money" as a result of the general level of the prices increase. On the other hand, every price increase is not inflation. The discrimination here is in the determination when the increase process is inflationary (Karakayalı, 2008).

As another inference, it is interpreted as balancing process by starting to reduce the total supply with increase in the general level of the prices after increasing of total demand more than supply (Flamant, 1952).

2.8.1 Import inflation

In outward economies, the price differences (for example, the barrel price of the petrol in foreign currency) of the foreign trade goods in the international markets causes to increase import input cost and value loss of local currency expect the variation in exchange rates.

2.8.2 Inflation inertia

The inflation inertia also is the exhibition keeping up tendency the expectations of economic actors for “future inflation” from today due to the high inflation processes pointed out by past events and experiences. This situation is to become resistant of the inflation in decrease direction with the reflections of economical behaviours and decisions and generation of the price inflexibility.

When the interaction of the exchange rates with the inflation expectations effects the pricing behaviour over “indexing”, for example the studies made over Turkey, it is shown that the sensitivity of the inflation to the exchange rate can be high even if in sectors such as services which the import input rate is relatively lower in high inflation environment before the floating rate. This exchange rate and result of the inflation which plays role of cycle feeding to each other is explained as “indexing behaviour” occurring with the protection motive against the inflation (Kara et. all, 2017).

2.8.3 Inflation targeting

The inflation targeting regime expresses the price stationarity carried out by the central banks. In other words, it is the use strategy of tools of monetary policies in the manner that would be worked in this direction by announcing the inflation level determined as main target by the central bank (Oktar, 1998).

In this method, the inflation is directed by the money authority of tools of monetary policies according to the deviation between expected and targeted values (McCallum et. all, 1990).

While the studies directed to exchange rate pass-through in academic environment since the 1980s, this subject has more importance especially in countries where the inflation targeting regime is implemented. Because, the decision of the low exchange rate pass-throughprovide more opportunity and also facilitating of this to reach the inflation target of the central banks is come into question.

Also, knowing in which direction and speed the variability of the exchange rate effects the domestic prices is also important in terms of providing efficiency of “short term nominal interest rate” which is important tool of monetary policy and important channel of the monetary transmission mechanism in the inflation-targeting regime.

2.8.4 Dollarization (Euroization)

The "dollarization" fact can be confused with "money substitute" subject. Both subjects are addressed in different perspectives in the literature. The narrower money substitute concept is rather to substitute the foreign currency with local currency in the extent that the public authority allows due to purchasing power losses of local money.

The dollarization is also expressed the foreign currency liability increase occurring as a result of directing to the foreign open position in order to obtain the real positive gains by public and financial sector.

The money substitute is the exchange of the variables in narrow currency definition with the ones in local and foreign currencies. However, the dollarization is more comprehensive since it is meant that the local currency substitutes by the foreign currency in the meaning of three basic functions of the local currency.

It is seen that the dollarization was converted to the "money substitute" after using as store of value of the assets in foreign current at first stage in the development process of a country and immediately after spreading (Serdengeçti, 2005).

In the early stages of dollarization, only the foreign currency use comes to the forefront as tool of value variation with high amount. However, the foreign currency use spreads to each point of the economic life with the continuation of the inflation increase. This dimension of the process is the stage (situation) called as "dollarization".

2.9 Fisher Theory

According to this theory, it is defended that the nominal interest rates (interest observed in the market and quoted in the stock exchanges) and expected inflation act together without effecting the real interest rates. Pursuant to this, the rise occurring in the inflation due to positive correlation increases the nominal interest to the same extent, however it has no effect on real interest rate (difference between nominal interest rate of the relevant period and inflation rate). According to Fisher effect, a permanent variation in long term inflation rates causes to equal rate variation in nominal interests. Thus, it is assumed that the real interest rate will not change against monetary shocks (Fisher, 1930).

The %1 rise in the interest rates will accompany to %1 rise in the inflation. According to Fisher, the "nominal interest rate" is consisting of the sum of the "real interest" and "expected inflation". The real interest will not be affected from monetary variation in the economy to be balanced in full employment in the long term; however %1 increase in the monetary expansion can cause to %1 increase in the inflation rate according to "quantity theory".

$$i = r + \pi \qquad (2.\ 30)$$

The nominal interest rate (i) expressed in (Equation 2. 30) is consisting of the sum of real interest rate (r) and expected inflation rate(π).

Due to that the creditors would like to compensate the losses occurring in the purchasing power during the credit period as much as the expected inflation, this situation will reflect to the nominal interests. Thus, if it is accepted that there is no "monetary error", a variation in the inflation rate will be efficient on the nominal interest rate completely due to the real interest rates are fixed.

Also in "International Fisher effect", it is emphasized that the nominal interests are depended upon to the inflation with an approach that the right interest rate parity and purchasing power parity are addresses together from the assumption which the real interests among the countries are equal due to arbitrage. Thus, since the nominal interest covers the inflation and expectations, the inflation will also be accepted as high in the countries having high nominal interest.

2.10 Monetary Transmission Mechanism

The monetary transmission mechanism (MTM) is expressed the transmission of money policy variations of the central banks, i.e. variation in the nominal money stock and/or short term interest rates on the real income and inflation (Ireland, 2005).

In terms of the functioning, it is started with the money policy variation of the money authority in the first stage and in spite of that response of money and interest rates. In the second stage, these financial variations are not effected total demand and general level of the prices (Robinson and Robinson, 1997).

When the right total demand is changed from the monetary transmission mechanism, this variation is effective on the inflation by changing the general level of the local price (Atgür, 2017).

2.10. 1 Monetary transmission mechanism channels

The transmission period specific to money policies are passed over the certain channels. These channels can be examined under four titles as interest (short and long term), exchange rate, asset prices and credit channel (Mishkin, 1995). Also, it can be referred to bank credit (narrow credit channel), statement and risk undertaking channel and expectations channel (Phillips curve), property market and cost channels within this structure.

2.10.1.1 Exchange rate channel

The “exchange rate channel” is described the effects of the variations occurring in the exchange rate as a result of money policy implementations in an economy on the production and general level of the prices. In an outward economy, it is defended that the most important channel is exchange rate channel especially in the short term (Mishkin, 2007). In this context, the exchange rate transmission channel works both “directly” and “indirectly”. In direct channel, the movements in the nominal exchange rates are reflected to the domestic prices of the imported final goods. Compared to the indirect effect, the exchange rate channel is effective on domestic and foreign demands directed to domestically produced goods over change in real exchange rate (Atgür, 2017).

The “preference of exchange rate regime” implemented by a country also can be determinant on the money policy transmission mechanism. The variations in the money supply under the preference of fixed exchange rate can be affected the interest rates, prices and level of income (Altay, 2007).

It can affect the nominal exchange rate of the Central Bank with the interest rate and/or intervention by direct exchange buying and selling. The variation in the exchange rate causes to the capital inflow or outflow by changing the nominal interest rates. The adjustment of the exchange rate against the variation in such nominal interest rate is explained with “Uncovered interest rate parity (UIP) theory” (Samkharadze, 2008).

The domestic currency gains value against foreign currency as a result of the “Contractionary Monetary Policy” implementation due to increase in the interest rates. According to this, the appreciation of the domestic currency affects the total demand over two different mechanisms. The first one, it is the increase in the domestic goods prices in local currency with the “relative price effect”. The increase in imports of the goods and service has negative effects on the exporters and causes to decrease in demand (Demchuk et al, 2012).

In outward economies, it effects monetary policy production volume over net export in the exchange rate channel. When primarily the domestic interest rates is decreased in this mechanism working over “Uncovered interest parity condition, it is to make the deposits in the domestic currency less attractive by decreasing the national currency. Thus, it is explained with “Marshall Lerner condition” and “elasticity of substitution” between the domestically produced goods and the goods produced abroad and causes to increase in net export. The factors determining the efficiency of the exchange rate channel are sensitivity of the exchange rate against interest rate, openness level of the economy and size of the economy. This channel works more efficiently in smaller or more openness economy (Tahir, 2012).

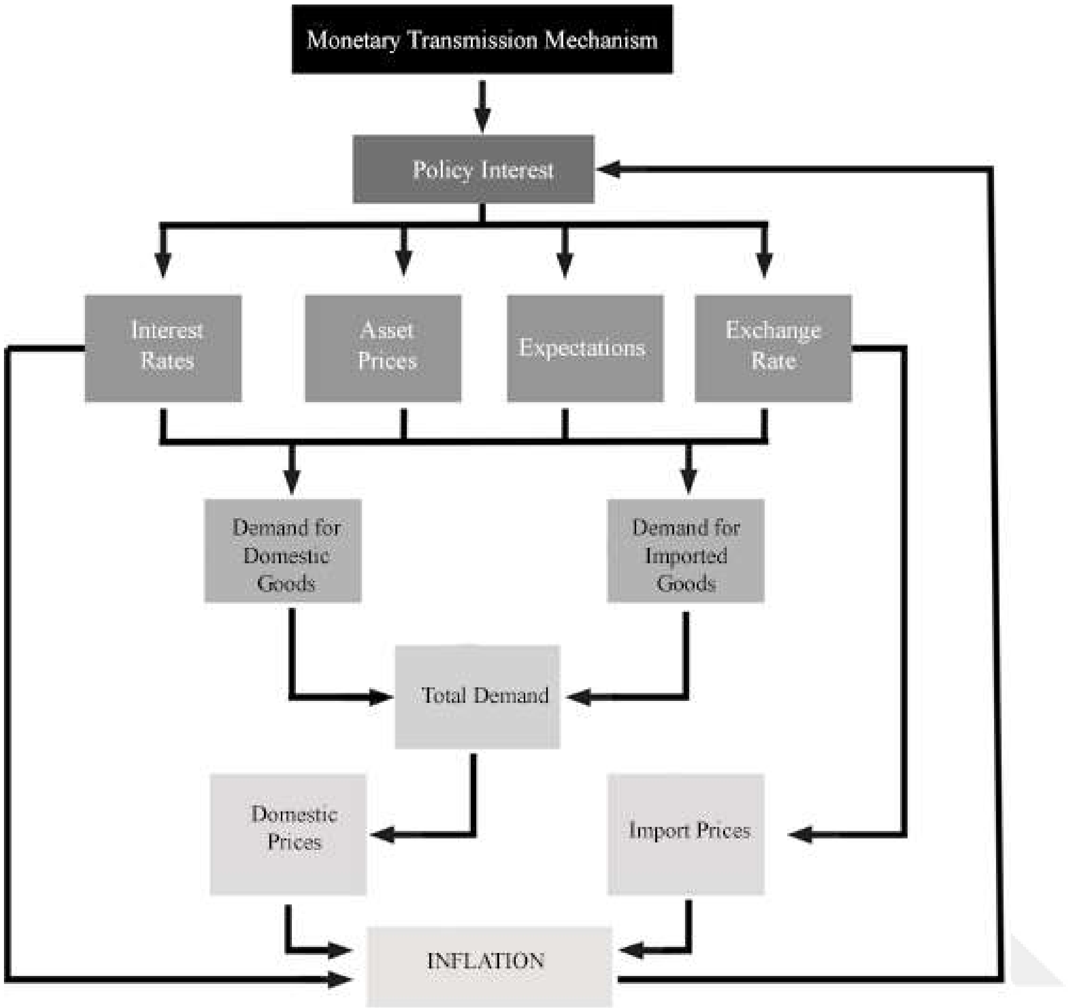


Figure 2.2: Monetary transmission mechanism (MTM).

2.11 Exchange Rate Pass-Through

The "Exchange rate pass-through cannot be explained in a single or common patterns detected for every sector and country. Because, the market structure in the relevant country depends on the variables such as pricing policy, substitutability feature of the product, inflation structure and relative share of the export goods in the producer and consumer prices index basket. Also, it depends on many factors such as efficient exchange rate policy, rate of non trading goods in the trade goods, inflexibility of non trading goods prices and fees and market share of the foreign trade goods. On the other hand, other important determinants of the pass effect are income level per capita, binary distances, tariffs and fees (Hyder and Shah, 2004).

The exchange rate pass effect expresses the transmission of the variation occurring in the exchange rates of a country to the import (export) goods prices or domestic prices. When the variation in the import (export) goods prices is lower than the variation in the exchange rate, it can be mentioned that the pass-throughis partial or deficient. The partial pass-throughis resulted from the different pricing for each market by the companies having market efficiency in the divided market structure (Acet, 2015).

According to this, the pass effect expresses the percentage change of the %1 variation in the import prices in the exchange rate of the national currency (Goldberg and Knetter, 1996).

2.11.1 Direct channel (First stage reflection)

The pass effects in the exchange rate to the domestic prices carries out over two channels as directly and indirectly in the outward economy. In direct channel, first of all the domestic prices are effected via imported final goods. Secondly, the increase in the exchange rate (depreciation of national currency) rises the costs of domestically produced goods by increasing the prices of the imported intermediate goods in the national currency, thus it also will increase prices of the final goods produced in that country (Acet, 2015).

2.11.2 Indirect channel (Second stage reflection)

The indirect channel also is to affect the net export by the variations in the exchange rate. The depreciation of domestic money causes to the increase of foreign demand directed to export goods by lowering their prices. The domestic demand is directed to the export goods and export substitute goods as a result of becoming more expensive. Thus, the prices of these goods also are increased with the increasing competition. Also, the increasing demand starts to create upward pressure in the production labour costs directed to the domestic goods (indirect pass effect).

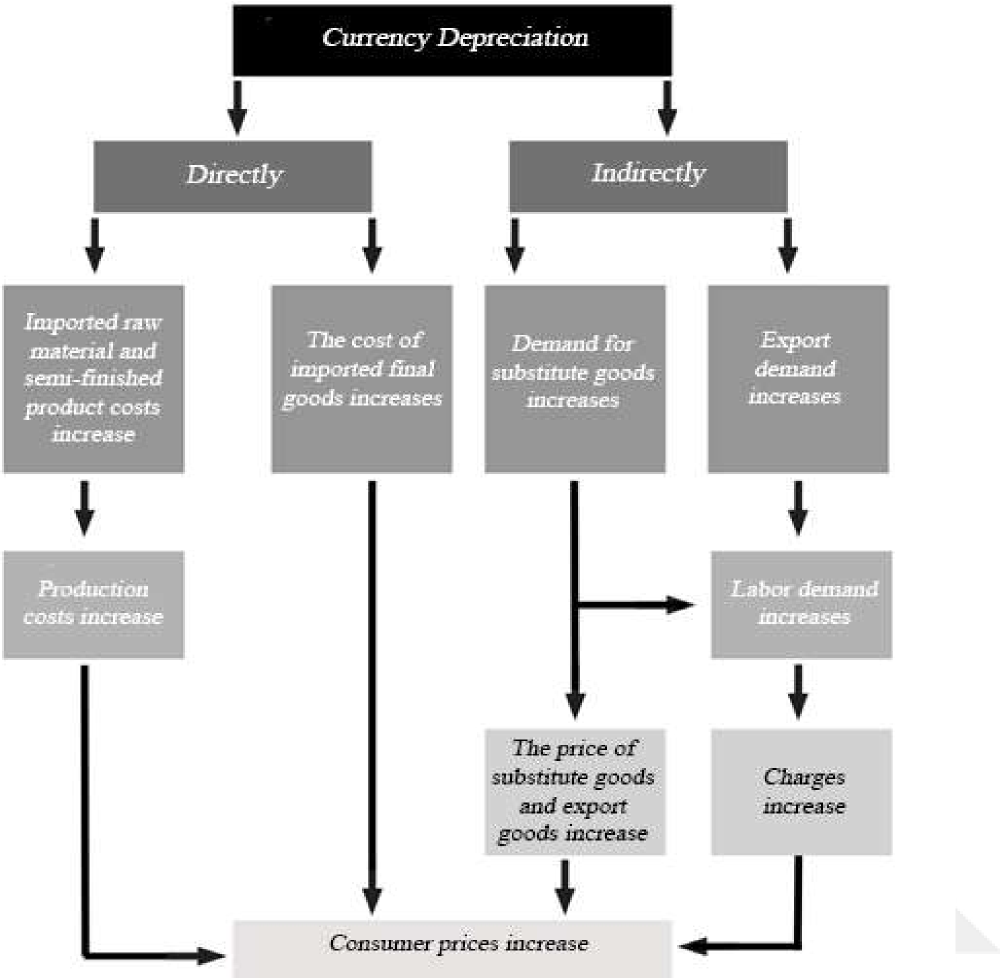


Figure 2.3: Exchange rate pass effect channels (ERP).

While the direct channel expresses the "first stage reflection" of the exchange rate transitivity, the indirect channel also expresses the "second stage reflection". In this stage, it includes the reflection of the shocks coming to the import prices to the indicators such as producer prices and consumer prices. Here, the effect of the second stage pass-throughis lower than the first stage. The reason of this is generally to include non trading goods which can be affected from domestic prices of the stock price indexed and resulted from the feature which can be compensated a part of exchange rate variation of the wholesaler and retailers in the importer country (Ghosh & Rajan, 2007).

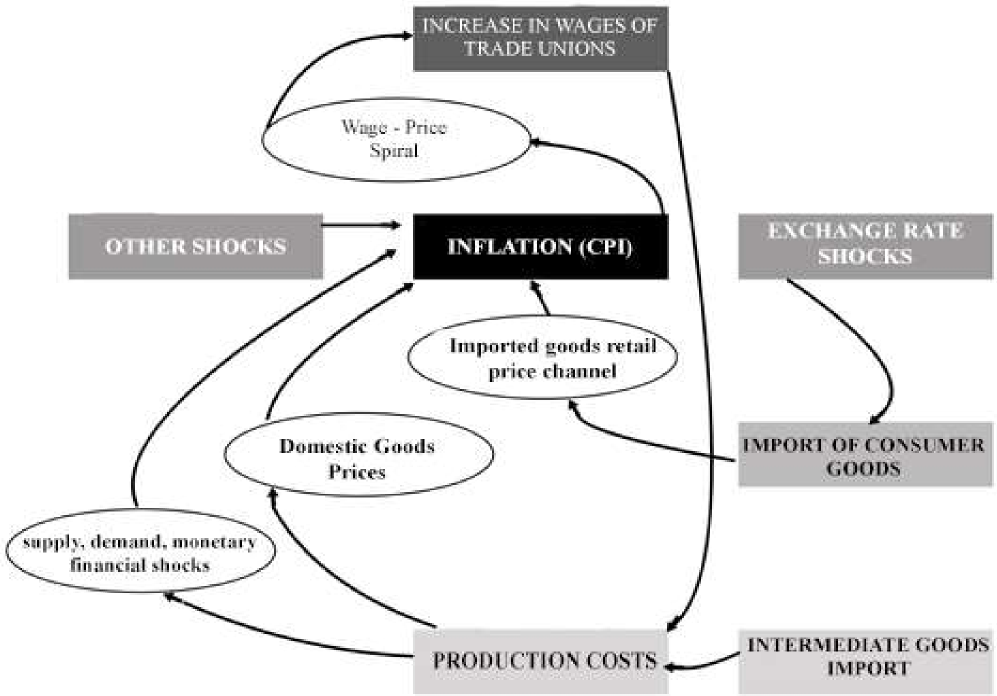


Figure 2.4: Economic shocks and pass effect channels relationship.

2.12 Theoretical and Analytical Framework of Exchange Rate Pass-through

There is a powerful relationship between price and cost increase occurring in the economy suddenly and resulting from foreign shocks and the exchange rates. However, it is explicit that the effect of the exchange rate on the prices has priority in the question of do the prices effect the exchange rate or do the exchange rates affect the prices. The reason of this, the effect of prices on the exchange rate only can be occurred with feedback.

The starting point of the exchange rate pass-throughis "Law of one price" and "Purchasing power parity" explained in the previous titles in detail.

If the companies reflect the variation in the exchange rate to their prices in one to one rate, i.e. fully, the full pass-throughand if they reflect a part of the shock, the partial (uncompleted) pass-throughcomes into question. If the companies never change the sales prices after the variation in the exchange rate, it can be said that there is no pass-througheffect (Acet, 2015).

Under the assumption that there is full competition, in other words the prices are full flexible and the "Purchasing power" parity always works, it is accepted that the exchange rate pass-throughshould be carried out automatically, completely and immediately (Arı, 2010).

There is condition that many theoretical assumptions should be valid in the “Law of one price” and “Purchasing power parity” approaches. In fact, the factors such as distribution and value added for transportation, sales of the imported goods are come into question. Therefore, the price of the goods sold in every country should be differentiated. In other words, the “Purchasing power parity” cannot work at all times and there is not full pass-through(Arı, 2010).

In the mathematical frameworks of “Exchange rate transitivity” and “Pricing to market” concepts, when A country is importer and B country is exporter, assume that only the trade of a Y goods is made. (E_B^A) nominal exchange rate showing the variation rate of A country currency according to B country currency.

In case of the relative “Law of one price” validity and in (equation 2.30) which all variables are expressed in the “logarithmic” manner;

$$\frac{\Delta lnP_Y^A}{\Delta lnE_B^A} = \frac{\Delta lnP_Y^B}{\Delta lnE_B^A} \qquad (2.30)$$

In (Equation 2. 30), (P_Y^A) shows the price of Y goods in A country currency, (P_Y^B) shows the price of Y goods in B country currency. The exchange rate pass-throughto the A country currency (prices) are shown at left side of the (Equation 2. 30). The exchange rate pass-throughto the B country currency (prices) is shown with the first term at right side of the (Equation 2. 30). If it is;

$$\frac{\Delta lnP_Y^B}{\Delta lnE_B^A} = 0 \qquad (2.31)$$

It is expressed that the exporters in B country don’t make pricing according to the market against the exchange rate in their countries and the exchange rate pass-throughaccording to the import prices in A country is full. If it is;

$$\frac{\Delta ln\ _Y^B}{\Delta lnE_B^A} = -1 \qquad (2.32)$$

It is expressed that the exporters in B country make pricing according to the full market and the exchange rate pass-throughaccording to the import prices in A country is zero (0). Under imperfect competition conditions, (P_Y^B) also can be written as in (equation 2. 33);

$$lnP_Y^B = \ln MC_Y^B + ln\left[MKP_Y^B\left(E_B^A\right)\right] \qquad (2.33)$$

In (Equation 2.12d), (MC) shows the marginal costs in the logarithm *(log)* and (MKP) shows the profit of the exporters. Generally, it is accepted that (MC) is fixed against the variation in the exchange rate and (MKP) changes with the exchange rate (equation 2. 34).

$$-1 < \frac{\Delta lnMKP_Y^B}{\Delta lnE_B^A} < 0 \qquad (2.34)$$

In (Equation 2. 34), in the extent that the pricing is high according to the market made by the exporters in B country, the exporter companies in B country are disposed to increase their profit against depreciation in the currency as response. If it is,

$$\frac{\Delta lnMKP_Y^B}{\Delta ln\ {}_B^A} = -1 \qquad (2.35)$$

$$\frac{\Delta lnP_Y^B}{\Delta lnE_B^A} = -1 \qquad (2.36)$$

It becomes

$$\frac{\Delta lnP_Y^A}{\Delta lnE_B^A} = 0 \qquad (2.37)$$

On the other hand, if it is

$$\frac{\Delta lnMKP_Y^B}{\Delta lnE_B^A} < -1 \qquad (2.38)$$

It becomes

$$\frac{\Delta ln P_Y^B}{\Delta ln E_B^A} < 0 \qquad (2.39)$$

This also is expressed even if more than full exchange rate transitivity. Assume that B country imports the intermediate good from A country. In this situation (equation 2. 40);

$$\Delta ln MC_Y^B = ln\left[MC_Y^B\left(E_B^A\right)\right] \qquad (2.40)$$

and (equation 2. 41) becomes

$$-1 < \frac{\Delta ln MC_Y^B}{\Delta ln E_B^A} < 0 \qquad (2.41)$$

In other words, the depreciation in the B country currency increases the intermediate goods supply costs from the A country. To the extent that the dependency of B country to the intermediate goods imported from A country and the import flexibility are high, the possibility to be the (equation 2. 42);

$$\frac{\Delta ln MC_Y^B}{\Delta ln \ {}_B^A} = -1 \qquad (2.42)$$

is high in that rate. In that case; it is (equation 2.43)

$$\frac{\Delta ln P_Y^B}{\Delta ln E_B^A} = -1 \qquad (2.43)$$

The structure which the B country import the intermediate goods from the A country and also export the final goods to the A country is called as “Production share”. In this manner, the level of exchange rate pass-throughto the A country, i.e. to the importer company is decreased.

3. DETERMINATION OF PASS-THROUGH EFFECT FROM EXCHANGE RATES TO DOMESTIC PRICES IN TURKEY IN 2003-2017

In this chapter of the study, the size and degree of pass effect of the exchange rates on the general level of the domestic prices within Turkish economy will be examined in a time-based framework. The purpose of the study is to analysis in what degree, how long and in which direction the variations in the exchange rates affect the general level of the domestic prices with VAR (Vector Autoregressive) model and as empirical.

The factors determining the effect of the exchange rate on the general level of the domestic price has been detailed in the previous chapter of the study.

3.1 Literature

When examined the studies in the literature, it is seen that the study of McCarthy (2000) which measures the effect and size of the exchange rates on the general level of the domestic prices with VAR model paves the way of the calculations in this direction. In the study of McCarthy, although the pass-throughfrom the exchange rates to PPI (Producer price index and CPI (Consumer price index) is weak relative to the transition effect on import prices, it has been revealed that the PPI is sensitive to the import price shocks more than the consumer prices.

3.2 Model

In this study, the model used by (McCarthy, 2000) in his study is addressed as reference method. The pass effect along the "production change" is examined in the study. It will be examined in which way the external shock reflects (passes) to the from one sage to the other stage of the production chain (process) from end to end, in other words, it will be observed that the shock started in the exchange rate reaches to the consumer prices after how it creates an effect on the producer prices.

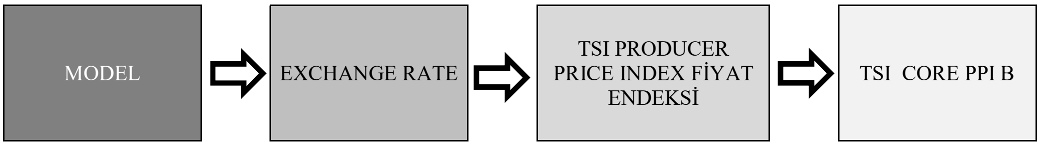


Figure 3.1: Exchange rate pass-throughequation model.

3.3 Applied Methods

1 direct pass channel will be examined by using 3 different variables. Respectively, “Augmented Dickey-Fuller (ADF)” and “Phillips Perron (PP)” tests and the stationarity of the variables are questioned in order to determine the stationarity of the series and possibility of co-integration test in the first stage. Thus, the “Unit root” test has been implemented to the variables.

In next stage, it has been looked at whether there is long term relationship between time series or not by implementing the co-integration test of Johansen (1988).

In the event that the co-integrated relationship between the variables is determined, the existence of short term relationships (VECM) between the variables and Granger causality (with VECM) of it has been analysed.

The “cumulative effect- response coefficient” of the inflation price index to the exchange rate is estimated by using “Impulse response function” and “pass effect coefficient” is estimated by comparing the exchange rate to the its own cumulative impulse response function coefficient. In other words, the findings related to the speed and the level of the pass-throughhas been derived from impulse response function results.

In last stage, the “variance decomposition” and the sources and levels of variations occurring in its own and other variables have been searched.

3.4 Econometric Methodology

3.4.1 Stability concept

The "deterministic" and "stochastic features" of the data should be understood in the time series analysis. The "deterministic" feature of the time series is whether there are a constant, trend and seasonality analysis components or not. The stochastic features of it also are the examination of variables and stationarity features.

The “stationarity” is defined as there is no continuous increase or decrease in the time series data for a certain period and the data shows scatter along the time axis. The series which the data is distributed around a fixed average and its average and variant is not changed in time are called as “stationary”. In both single and system based approaches, it should be considered that the time series of the co-integration analysis are stationary and not, because the integration level of the stationary series is zero. It is avoided the issues such as invalid test statistics and spurious regression by revealing the stationarity concept in time series.

If (Y_t) is stationary, it should have following features (Gujarati, 1999; Tarı, 2010);

$$Average = E(y_t) = \mu \; (for\ all\ t's) \qquad (3.1)$$

$$Variance = E(y_t - \mu)^2 = Var(y_t) = \sigma^2 \; (for\ all\ t's) \qquad (3.2)$$

$$Covariance = E[(y_t - \mu)(y_{t+k} - \mu)] \qquad (3.3)$$

$$Covariance = Cov(y_t, y_{t+k}) = \gamma(k), (k = 1, 2, 3, \dots) \qquad (3.4)$$

If the time series is stationary according to these features and expressions, its average, variance and covariance will be remained same without changing notwithstanding when it is measured.

The (Equation 3.1) and (Equation 3.2) express that the average and variant of the stochastic process is constant. In (Equation 3. 3), the covariance between any two values of the series is not depended on a certain time point (t) and it is only depended on time interval between two values(k). According to this, these three factors, i.e. average, variance and covariance shows whether the stochastic process is a time function or not. If the purpose in the forecasting of the regression model is to take a significant guess already, this is only possible with being stationary of the stochastic process along the time axis (Yavuz, 2004).

3.4.2 Determination of the stability of series

In the event that the econometric techniques should be used in the economic analysis, the investigation the statistical feature of the relevant time series is the first stage. The first step is to provide stationarity conditions of the series.

The investigation whether the series are stationary or not is made with unit root tests. Dickey-Fuller's (1979, 1981) parametric unit root tests "DF" and "ADF" and Phillips - Perron's (1988) non-parametric unit root test are used in the investigation of "PP" stationarity.

When the error term (ε_t) has correlation, Augmented Dickey-Fuller, ADF tests (ADF, 1979) respectively for "lean", "fixed nominal" and "fixed nominal and trend regression models";

$$\Delta Y_t = \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \varepsilon_t \qquad (3.5)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \varepsilon_t \qquad (3.6)$$

$$\Delta Y_t = \alpha_0 + \alpha_1 trend + \alpha_2 Y_{t-1} + \sum_{i=1}^{k} \beta_i \Delta Y_{t-1} + \varepsilon_t \qquad (3.7)$$

Here, (t) is the variable expressing the time or general trend (trend component according to the time). (Y) expresses the variable subjected to the stationarity test, (Δ) difference operator, (ε) error term.

$H_0: \alpha_1 = 0$ and $H_1: \alpha_1 < 0$

In this approach which the hypotheses are tested;

(H_0) In the case of the hypothesis is rejected $(H_1: accepted)$, it is come out with result that the series addresses is stationary, i.e. there is no unit root.

(H_0) In case of the hypothesis is irrefutable $(H_1: Rejected)$, it is come out with result that the series addresses is not stationary, i.e. there is unit root.

The non parametric unit root test bringing by Phillips and Perron (1988) also can be used in the event that there is autocorrelation and changing variance problems in the error terms. The deficiencies of ADF Test are eliminated in this point. The PP Test is a stationarity test which has MA- Moving Average process and is non parametric.

The (δ) coefficient in the following model is based on the correction of t-statistics of series correlation and changing variance for the calculation of PP test.

$$\Delta Y_t = \alpha_0 + \alpha_1 trend + \delta Y_{t-1} + \sum_{j=2}^{p} \delta_i \Delta Y_{t-j+1} + \varepsilon_t \qquad (3.8)$$

PP Test statistics formula;

$$\tau_\delta = t_\delta \left(\frac{\gamma_0}{f_0}\right)^{1/2} - \frac{T(f_0 - \gamma_0)\left(se(\hat{\delta})\right)}{2f_0^{\frac{1}{2}}s} \qquad (3.9)$$

$(\hat{\delta})$ express coefficient forecasting, (t) value of (t_δ), (δ), standard error of $se(\hat{\delta})$, (δ) coefficient and (s) regression standard error. (γ_0) equation is error variance forecasting. f_0 is spectral error forecasting from frequency.

Especially in the series which includes trend, if the MA processes are increase, Phillips-Perron test is more powerful than Dickey-Fuller test. If the MA processes are negative, ADF tests are powerful than Philllips - Perron.

3.4.3 Johansen Co-integration test

Johansen co-integration method is consisting of the VAR- Vector Autoregression forecasting including “1. Differences” of non-stationarity series and “level grades”. In two non-stationarity time series such as *(X)* and *(Y)* as per the level grades, VAR model to be created for co-integrated test provided that there is vector including *(Z)*, *(X)* and *(Y)* series;

$$\Delta y_t = \sum_{i=1}^{k-1} \delta_i \Delta y_{t-i} + \pi y_{t-k} + u_t \qquad (3.10)$$

$(\delta_i y_t)$ is the coefficient matrix of the variables showing the delays of first difference of the vector. (π) indicates the coefficient matrix for the variable levels. (u_t) describes the error terms of the VAR model. The test is based on the ranking of (π) matrix. If, the ranking of (π) matrix is zero, there is no co-integration relationship (y) between variables created the vector. If the ranking of (π) Matrix is one (1), it expresses that there is a co-integration relationship among the series created (y) vector, in other words, they are acted together in the “long term”.

Being ranking of (π) matrix is greater than one (1), is shown that there is more than one co-integration relationships between the time series examined (Brooks, 2008).

In Johansen co-integration method, the co-integration relationships between non-stationarity series is questioned through two statistical information named as "Trace" and "Maximum Eigenvalue" (Tarı, 2010).

Trace Test:

$$\lambda_{trace} = -T \sum_{i=1}^{n} ln\left(1 - \hat{\lambda_i}\right) \qquad (3.11)$$

Maximum Eigenvalue Test:

$$\lambda_{tmax} = -T\ ln\left(1 - \widehat{\lambda_{r+1}}\right) \qquad (3.12)$$

(λ) is the eigenvalues obtained from (π) matrix. It is measured the $(H_0: r \leq r_0)$ assumption expressed that the ranking is equal or smaller than (r_0) against the $(H_1: r \geq r_0 + 1)$ alternative assumption expressed that the ranking is equal to $(r_0 + 1)$ or greater than $(r_0 + 1)$ by looking ranking of trace test (π) matrix. The maximum eigenvalue statistics also measures the $(H_0: r = r_0)$ zero assumption which the number of co-integrated vector is (r_0) against $(H_1: r = r_0 + 1)$ alternative assumption. In the event that the result statistics is greater than the critical values in a certain significance level, the zero empty hypothesis assumption will be rejected, otherwise will be accepted.

3.5 Vector Autoregressive Models (VAM): Long Term Relationship

Being the relationship and interaction between the economic indicators are complex and multi-directional requires the use of system of simultaneous equations. The difficulties of the dependent and independent variable detection stage occurring as a result of mutual interaction between the relevant indicators effects the consistency of the analysis negatively. Therefore, it is required to put some restrictions on the structural model in order to overcome the variable detection problem in the simultaneous equation systems (Acet, 2015).

The co-integration concept used in the practical statistics is a basic assumption regarding the reveal process of the "long term" relationships between time series. The VAR Analysis has been developed as criticism to the simultaneous equation systems used in estimation of the mutual dependency between time series and using the delayed values of the variables. The "endogenous and exogenous variables" are used in time series analysis which its discrimination is not made in net and is not restricted on the structural model (Gujarati, 1999).

Two stage processes come into question in the manner that would be created some restrictions in order to classify the variables as endogenous and exogenous and to define in the simultaneous equations model. (Sims, 1980) has developed methods such as dynamic simultaneous equations systems, impulse response function and variance decomposition instead of criticising this structure on account of the fact that it includes artificial intervention (Maddala, 2001). According to Sims, if there is simultaneity between the variables, all of the relevant variables should be addressed equally and should not make any discrimination in the endogenous and exogenous variables manner. A simple VAR model can express as (equation 3.13 and 3.14) (Gujarati, 2001).

$$Y_t = \alpha_1 + \sum_{i=1}^{p} b_{1i}x_{t-i} + \sum_{i=1}^{p} b_{2i}y_{t-i} + u_{1t} \tag{3.13}$$

$$X_t = c_1 + \sum_{i=1}^{p} d_{1i}y_{t-i} + \sum_{i=1}^{p} d_{2i}x_{t-i} + u_{2t} \tag{3.14}$$

The explanation of the causal relationship of the vector autoregressive model (VAR) between the variables which are not being non-stationarity, however are being co-integrated with "Vector Error Correction Model (VECM)" would be a tendency giving weight to the recent studies in the literature in order to detect causal relationship between the variables which are non-stationarity and is evidenced there is no co-integration relationship (Tarı, 2010).

3.6 VECM Model: Short Term Relationship

It is a restricted co-integrated VAR model having co-integration relationships between each other and used for non-stationarity series. How long the deviation in long term balance can correct in the short term is given the error correction term (adjustment coefficient). General representation of VECM Model;

$$\Delta Y_t = \alpha_1 + \sum_{i=1}^{p} b_{1i}\Delta X_{t-i} + \sum_{i=1}^{p} b_{2i}\Delta Y_{t-i} + \sum_{i=1}^{p} \lambda_1 EC_{t-1} + u_{1t} \tag{3.15}$$

$$\Delta X_t = c_1 + \sum_{i=1}^{p} d_{1i}\Delta Y_{t-i} + \sum_{i=1}^{p} d_{2i}\Delta Y_{t-i} + \sum_{i=1}^{p} \lambda_2 EC_{t-1} + u_{2t} \tag{3.16}$$

The VECM model is created by adding "co-integration vector error terms" to the VAR model. When there is no common integration among the variables, the VECM model is converted to VAR model. The error terms (residuals) created in (EC_{t-1}) co-integration equation express one (1) delayed value and names as "error correction parameter".

The error correction parameter provides to balance model dynamic and forces to converge the variables to long term balance value. The significant output of error correction parameter coefficients (λ_1) and (λ_2) statistically reveals the existence of the deviation and being the coefficient is minus, lower than one and significant reveals a relationship converged to the balance. The magnitude of the coefficients is the indicator of the convergence speed through to the long term balance value (Muratoğlu, 2011).

3.7 Interpretation of VAM Model Granger's Test

If the VAR model created includes a large number of delays of the variables, it is grown difficult to determine the independent variable groups of dependent variables affecting each other. Therefore, the causality test determined by (Granger, 1969) is used. This test searches an answer to the questions such as does the variation in (y_1) cause to variations in(y_2). According to this, if the variation in (y_1) causes to the variations in(y_2), the delays of (y_1) should be significant in equality belonging to(y_2). In this case, the expression that there is Granger causality from "(y_1) through(y_2). The Granger causality can be single and double directional. On the other hand, when there is accurate causality from (y_1) to (y_2) and there is no accurate causality from(y_2) to (y_1), it can be said that (y_1) is an exogenous variable in the equity belonging to (y_2). Also, if none of delays belonging to (y_1) and (y_2) are not significant in the equity of the other variable statically, it can be said that the relevant two variables are "independent" variables.

3.8 Impulse Response Functions

It is calculated the sensitivity of the dependent variables in VAR Model to the shocks belonging to other variables. The measurement of combined response to be given by other variables against one (unit) standard deviation shock to be implemented to the equation system is made via impulse response analysis (Acet, 2015). The impulse response analysis is a method providing to measure how and in which direction both the relevant independent variables and other variables against shocks to be given to each variable in the equation respectively. The capability of this analysis depends on the existence of causality between the variables.

Therefore, "one unit" shocks are implemented to the error term for each variable in each equation and the variations of it created in VAR system in time are observed. According to this, if there are (g) variables; it can be created (g^2) impulse response functions. In order to achieve this, it should be addressed the VAR model with "Vector moving average (VMA) form. In the event that the system is stable, the implemented shock will be disappeared gradually in time. In order to exemplify the process; provided that it will be

$$A_1 = \begin{bmatrix} 0,5 & 0,1 \\ 0 & 0,4 \end{bmatrix} \tag{3.17}$$

assume a VAR model with 2 variables;

$$y_t = A_1 y_{t-1} + \mu_t \qquad (3.18)$$

Its expansion;

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} 0,5 & 0,1 \\ 0 & 0,4 \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \end{bmatrix} \qquad (3.19)$$

The effect of “1 unit” shock seen in at (y_{1t}) in $(t = 0)$ period (y_{1t}) during $(t = 0, 1, 2, 3, \ldots)$ periods will be continued as

$$y_0 = \begin{bmatrix} \mu_{10} \\ \mu_{20} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix} \qquad (3.20)$$

$$y_1 = A_1 y_0 = \begin{bmatrix} 0,5 & 0,1 \\ 0 & 0,4 \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} 0,5 \\ 0 \end{bmatrix} \qquad (3.21)$$

$$y_2 = A_1 y_1 = \begin{bmatrix} 0,5 & 0,1 \\ 0 & 0,4 \end{bmatrix} \begin{bmatrix} 0,5 \\ 0 \end{bmatrix} = \begin{bmatrix} 0,25 \\ 0 \end{bmatrix} \qquad (3.22)$$

The impulse response functions belonging to (y_{1t}) and (y_{2t}) against one (1) unit shock seen in (y_{1t}) can be written from this point. Due to the sign of (y_{1t-1}) variable is zero (0) in equity belonging to (y_{2t}), the effect of the shock on (y_{2t}) always will be zero (0).

3.9 Variance Decomposition

In case if most of the variations on a variant are based on the shocks in itself, this indicates that the variant moves as “externally”. Variance decomposition also provides information for the degree of causality relations between the variables (Enders, 1995).

Variance decomposition introduces the sensibility of the dependent variables in the VAR model against its own shocks. A shock occurring on a variable in the system (i) affects firstly the variable itself and then the other variables due to the VAR model’s dynamic structure. It determines that the amount of estimated error variance of a given variable after (s) steps can be explained by the shocks observed on each independent variable at periods (s = 1, 2, 3, ...).

Impact-response functions and the " sorting" (order) of the variables in the variance proportion are important. It is because that the error terms belonging to the other equations are considered to be constant while a shock observed in an error term of an equation is examined.

3.10 Model Application

3.10.1 Data: Time series

In the study, for the " analysis of pass-through effect of exchange rate to the domestic prices", 3 time series were used as variable which are each based on 180 ‘‘monthly’’ observations covering the last 15 years period between 2003: 01 and 2017: 12.

Table 3. 1: Data set.

VARIABLE	DEFINITION
s1_dvzspot	Exchange Rate (0.5 X EUR/TL + 0.5 USD/TL)
s2_ufe	TUIK Consumer Price Index
s3_tufe_cb	TUIK Core Consumer Price Index *

* Special scope CPI indicators (2003=100)	
Core group	
B	Unprocessed food products, energy, alcoholic drinks, tobacco and gold excluded CPI
	Is the continuation of the old special scope H indicator.

The reason that for starting of the data-set since 2003 is that it is possible to introduce a current analysis that is free from the crisis effects - to be more objective in the quality and consistency of the data - due to the crisis experienced in 2001. Variables used are respectively;

(s1_dvzspot) ; Based on EUR / TL and USD / TL; month-end exchange basket closing price weighed at 50% / 50% ratio,

(s2_ufe) ; Turkish Statistical Institute (TUIK) Producer Price Index (Formerly Wholesale Price Index-WPI),

(s3_tufe_cb) ; Turkish Statistical Institute (TUIK) Core Consumer Price Index (Special scope CPI indicators, core group B, processed food products, energy, alcoholic drinks, tobacco and gold excluded CPI).

Expression of the variables in parentheses is written as it is named in the computer software where the statistical calculations of the data are recorded *(IHS Global Inc. EViews 9.5 Enterprise Edition, 64 bit)*. *MS Office Excel 2016* is used while the tables are created.

The "special scope CPI indicators" which are created by eliminating all the temporary effects observed at the prices are calculated by gradually sorting the energy prices dependent on the price moves at the international markets, product prices based on the seasonal effects, prices determined in control of the giants and the indirect taxes (such as VAT, SCT) from the consumer price index.

Source of the data is TCMB’s electronic data dispense system EVDS.

Data frequency; The reason for being chosen as "monthly" is that the inflation index data is regularly published by TUIK at the beginning of each month.

3.10.2 Descriptive statistics

Identifier statistics table;

Table 3. 2 : Identifier statistics table.

VARIABLES	S1_DVZSPOT	S2_PPI	S3_CPI_CB
AVERAGE	2.1285	182.7181	172.4738
MEDYAN	1.8553	173.3700	161.3250
MAXIMUM	4.3005	316.4800	293.3300
MINIMUM	1.4293	96.0700	94.4600
STANDARD DEVIATION	0.6976	57.4298	52.3574
DEVIANCY	1.2763	0.3736	0.5162
KURTOSIS	3.7449	2.1494	2.2656
JARQUE-BERA	53.0310	9.6133	12.0394
PROBABILITY	0.0000	0.0082	0.0024
TOTAL	383.1293	32889.2500	31045.2900
TOTAL STANDARD DEVIATION	87.1093	590374.5000	490692.9000
OBSERVATION	180	180	180

In the graphic; while s1_dvzspot is represented on the right vertical y axis, s2_ufe and s3_tufe_cb are presented on the left vertical y axis of the graph. Horizontal x- axis indicates the time.

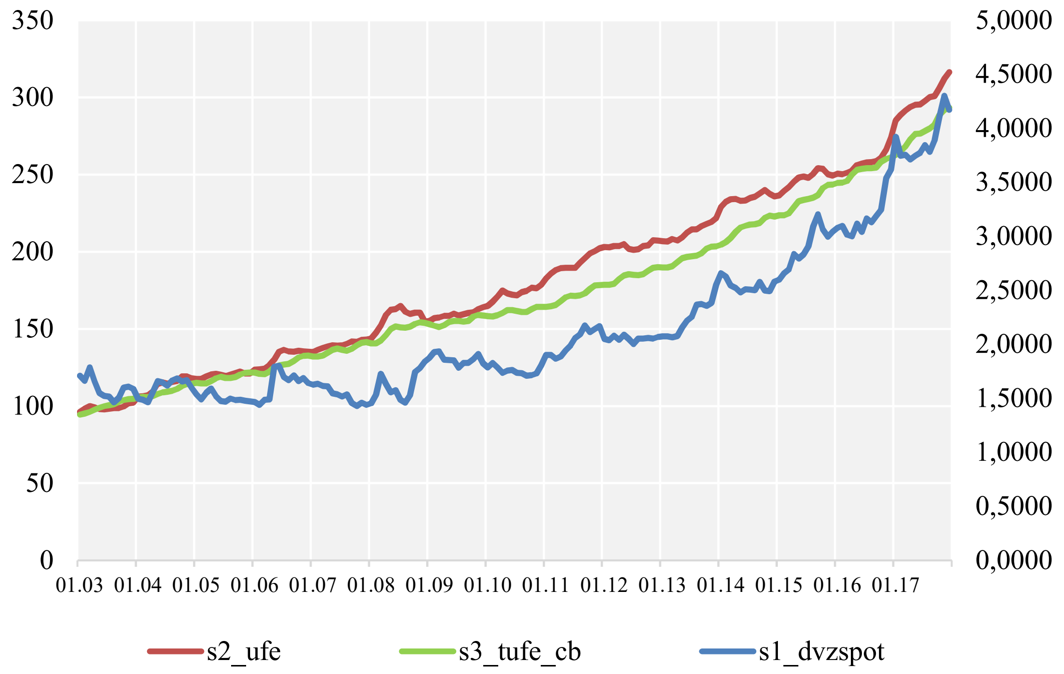


Figure 3. 2 : Zaman serisi verisi için grafiksel gösterim.

3.10.3 Unit root tests

Unit root features were examined using ADF and PP unit root tests without taking the logarithm of the series. T-statistic data was assessed according to 5% probability (significancy) criteria. Series are evaluated as "fixed" and "trendy-fixed". Its plain form is not examined. The reason for that is, a minimum fixed inflation reserve generally exists at the economies due to the "inertia" tendency of inflation.

According to the test results presented at Table 3.10.3, it can be seen that exchange basket (s1_dvzspot) is not ‘‘stable’’ on the levels of TUIK producer price index (s2_ufe) and TUIK special scope core CPI group B index variables but it is ‘‘stable’’ at the ‘‘1^{st} and 2^{nd} Difference Levels’’.

Table 3. 3 : Table of unit root test results

DICKEY-FULLER UNIT ROOT TEST					HYPHOTESIS	
FO CRITERIO	T-VALUE	P-VALUE	T-VALUE	P-VALUE	t > 0.05 H0: IRREPUTABLE	
Level	Constant	Max Lag:13	Trend&Constant	Max Lag:13	t < 0.05 H0: REJECTION	RESULT
Level	2.16	0.99	-0.60	0.97	t > 0.05 H0: IRREPUTABLE	NOT STABLE
Level	1.87	0.99	-0.76	0.96	t > 0.05 H0: IRREPUTABLE	NOT STABLE
Level	3.30	1.00	2.71	1.00	t > 0.05 H0: IRREPUTABLE	NOT STABLE
1. Difference	-12.13	0.00	-12.57	0.00	t < 0.05 H0: REJECTION	STABLE
1. Difference	-7.86	0.00	-8.18	0.00	t < 0.05 H0: REJECTION	STABLE
1. Difference	-0.80	0.81	-2.58	0.28	t > 0.05 H0: IRREPUTABLE	NOT STABLE
2. Difference	-10.45	0.00	-10.41	0.00	t < 0.05 H0: REJECTION	STABLE
2. Difference	-9.51	0.00	-9.49	0.00	t < 0.05 H0: REJECTION	STABLE
2. Difference	-4.94	0.00	-0.07	0.00	t < 0.05 H0: REJECTION	STABLE

RON UNIT ROOT TEST					HYPHOTESIS	
: Newey-West	T-VALUE	P-VALUE	T-VALUE	P-VALUE	t > 0.05 H0: IRREFUTABLE	
Level	Constant	SE:Bartlet	Trend&Constant	SE:Bartlet	t < 0.05 H0: REJECTION	RESULT
Level	2.60	1.00	-0.42	0.98	t > 0.05 H0: IRREFUTABLE	NOT STABLE
Level	2.39	1.00	0.14	0.99	t > 0.05 H0: IRREFUTABLE	NOT STABLE
Level	5.15	1.00	4.27	1.00	t > 0.05 H0: IRREFUTABLE	NOT STABLE
1. Difference	-12.13	0.00	-12.61	0.00	t < 0.05 H0: REJECTION	STABLE
1. Difference	-7.96	0.00	-8.10	0.00	t < 0.05 H0: REJECTION	STABLE
1. Difference	-8.49	0.00	-7.56	0.00	t < 0.05 H0: REJECTION	STABLE
2. Difference	-73.94	0.00	-73.94	0.00	t < 0.05 H0: REJECTION	STABLE
2. Difference	-33.72	0.00	-34.69	0.00	t < 0.05 H0: REJECTION	STABLE
2. Difference	-18.71	0.00	-18.59	0.00	t < 0.05 H0: REJECTION	STABLE

In the analysis *(AR Roots Graph)* that is applied at 1st difference level of which series of variables are detected to become simultaneously stable, points to be in the circle confirm the stabiliy.

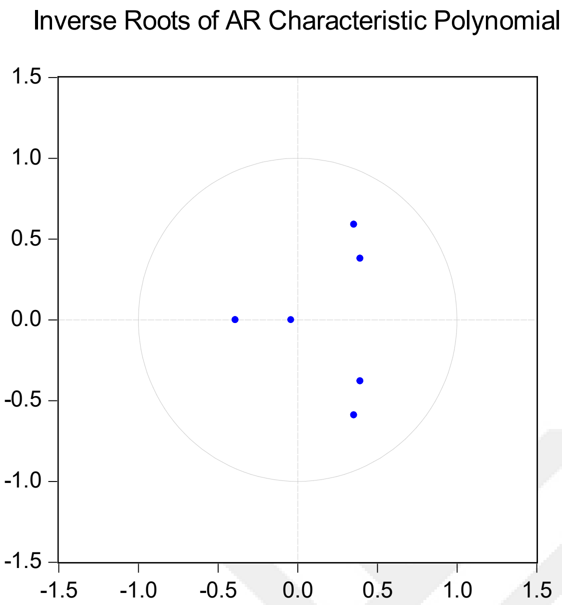


Figure 3. 3 : AR Roots graphic.

Considering this point, in case if the variables are "stable" in their first differences, it is necessary to determine whether the variables are cointegrated together or not. The cointegration of variables together gives the result that they have a linear combination between, meaning that they have a "long-term" relationship among them.

3.10.4 Johansen co-integration test

As the result of examining the stability of the series, it will be necessary to investigate the existence of "cointegrated vector" among these time series that are "not stable at level extent but stable at 1st difference level. Accordingly, using the method developed by Johansen, the existence of cointegration relation will be investigated and will be tested with "Trace test" and "Maximum eigenvalue test".

Since the "Johansen cointegration test" is sensitive to the delay times of the series, it is determined that delay lengths are detected at the VAR equation generated at the 1st difference level in which the series are found to be stable and determined as two (2) for the corresponding model.

Table 3. 4 : Determination of delay cycle for Johansen Cointegration.

JOHANSEN COINTEGRATION TEST 1st STAGE				
MODEL	Lag Intervals For Endogenous	AIC	SC	CHOICE
	Estimate			MINIMUM
Unrestricted VAR	1 1	3.00	3.07	
Unrestricted VAR	1 2	2.74	2.87	*
Unrestricted VAR	1 3	2.72	2.90	
Unrestricted VAR	1 4	2.75	2.98	

Table 3. 5 : Statistics of delays for Johansen Cointegration.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-442.3835	NA	0.032597	5.090097	5.144351	5.112104
1	-364.2645	152.6669	0.014795	4.300166	4.517180	4.388193
2	-334.9706	56.24436*	0.011734*	4.068235*	4.448010*	4.222283*
3	-326.5041	15.96529	0.011809	4.074333	4.616868	4.294401
4	-323.8604	4.894690	0.012704	4.146976	4.852271	4.433064

In the study carried out in this direction, the Johansen cointegration results are as in (Table 3.10.4c).

Table 3. 6 : Trace and eigenvalue test results for Johansen cointegration.

COINTEGRATION TEST (TRACE TEST)					
HYPHOTESIS	NO LIMIT		0.05		
COINTEGRATED EQUATION NUMBER	EIGENVALUE	TRACE VALUE	CRITICAL V.	P-VALUE	RESULT
H0:r =0 H1:r<=1 *	0.45	196.51	42.92	0.00	REJECTION
H0:r<=1 H1:r<=2 *	0.29	92.45	25.87	0.00	IRREFUTABLE
H0:r<=2 H1:r>=2 *	0.17	32.82	12.52	0.00	IRREFUTABLE

COINTEGRATION TEST (MAXIMUM EIGENVALUE)					
HYPHOTESIS	NO LIMIT		0.05		
COINTEGRATED EQUATION NUMBER	EIGENVALUE	TRACE VALUE	CRITICAL V.	P-VALUE	RESULT
H0:r =0 H1:r<=1 *	0.45	104.06	25.82	0.00	REJECTION
H0:r<=1 H1:r<=2 *	0.29	59.63	19.39	0.00	IRREFUTABLE
H0:r<=2 H1:r>=2 *	0.17	32.82	12.52	0.00	IRREFUTABLE

According to the test results, the trace test in Johansen cointegration test, it is seen that the null hypothesis of "no cointegration" at 5% significancy level is "rejected". The trace test shows that there are 3 "cointegrations" at the 0.05 significancy level.

Also, according to the eigenvalue test, the null hypothesis that cointegration does not exist at 5% significancy level was rejected. Likewise, the test confirmed that there were three (3) "co-integrations" at 0.05 significancy level. Thereof, according to the “2 delay lengths" determined in the VAR equation chosen considering Johansen cointegration test’s "test model number four (4)", the result that "at least 3 co-integrated vectors exist".

Estimated coefficients of the cointegration equation (VAR) of the test results;

+1,000 (s3_tufe_cb) = +1,070 (s1_dvzspot) + 0,258 (s2_ufe) + 0,006 (fixed/@trend)

3.10.5 Vector autoregressive and co-integrated VAR (VECM) model

For the analysis of the transition from the exchange rate to domestic prices, the vector auto-regressive (VAR) analysis which is developed by (Sims, 1980) will be used.

Since the "*cointegration*" relationship between the time series used to determine the transition to the general level of domestic prices from the exchange rate is determined in the previous stage of the test period, the equations that make up the vector error correction (VECM) model for multiple variables that will be used according to the equations in the definition section (Equation: 3.6a) and (Equation: 3.6b) are as follows;

$$\Delta s1\_dvzspot_t = a_1 + \sum_{i=1}^{p} b_{1i}\,\Delta s1\_dvzspot_{t-i} + \sum_{i=1}^{p} b_{2i}\,\Delta s2\_ufe_{t-i} +$$

$$+ \sum_{i=1}^{p} b_{3i}\Delta s3\_tufe\_cb_{t-i} + \sum_{i=1}^{p} \lambda_1\,EC_{t-1} + u_{1t} \qquad (3.23)$$

$$\Delta s2\_ufe_t = c_1 + \sum_{i=1}^{p} d_{1i}\,\Delta s2\_ufe_{t-i} + \sum_{i=1}^{p} d_{2i}\,\Delta s1\_dvzspot_{t-i} +$$

$$+ \sum_{i=1}^{p} d_{3i}\Delta s3\_tufe\_cb_{t-i} + \sum_{i=1}^{p} \lambda_2\,EC_{t-1} + u_{2t} \quad (3.24)$$

$$\Delta s3\_tufe\_cb_t = e_1 + \sum_{i=1}^{p} f_{1i}\,\Delta s3\_tufe\_cb_{t-i} + \sum_{i=1}^{p} f_{2i}\,\Delta s1\_dvzspot_{t-i} +$$

$$+ \sum_{i=1}^{p} f_{3i}\Delta s2\_ufe_{t-i} + \sum_{i=1}^{p} \lambda_3\,EC_{t-1} + u_{3t} \quad (3.25)$$

In the VECM equations above, (EC_{t-1}) indicates error correction term and (p) stands for the delay term.

(λ_1), (λ_2), (λ_3) ve (λ_4) are respectively error correction coefficients indicating the long-term relationship of $\Delta s1\_dvzspot$, $\Delta s2\_ufe$ and $\Delta s3\_tufe\_cb$.

$\Delta s1\_dvzspot_t$, $\Delta s2\_ufe_t$ and $\Delta s3\_tufe\_cb_t$ stands for the short-term dynamics and the coefficients in front of them indicates the short-term relationships.

(Δ) indicates the diference term and accordingly (t) the time and (u_t) the error terms that are not auto-correlated.

Table 3. 7 : Table of VECM variable coefficients.

EQUATION	1	DEPENDENT VARIABLE	$\Delta s1\_dvzspot_t$	
Variable	EC_{t-1}	$\Delta s2\_ufe_{t-1}$	$\Delta s3\_tufe\_cb_{t-1}$	a_1
Coefficient	0.005596	0.015112	0.000421	-0.005256

EQUATION	2	DEPENDENT VARIABLE	$\Delta s2\_ufe_t$	
Variable	EC_{t-1}	$\Delta s1\_dvzspot_{t-1}$	$\Delta s3\_tufe\_cb_{t-1}$	c_1
Coefficient	-0.10805	10.5816	0.342555	0.703857

EQUATION	3	DEPENDENT VARIABLE	$\Delta s3\_tufe\_cb_t$	
Variable	EC_{t-1}	$\Delta s1\_dvzspot_{t-1}$	$\Delta s2\_ufe_{t-1}$	e_1
Coefficient	-0.05135	0.133021	0.154736	0.917942

After the relationship between used variables is estimated according to the related vector error correction model equations, "estimated coefficients" of the variables that are specified in (Table 3.7) are determined. The (EC_ (t-1)) in the equations is the "error correcting term" and indicates the "set speed".

In the equations where the producer and core consumer price series are ($\Delta s2\_ufe_t$) and ($\Delta s3\_tufe\_cb_t$) dependent variables, coefficients (adjustment speeds) of (C_{t-1}) error terms are -0.10805 and -0.05135 respectively -as expected- that is "negative" signed, so they are statistically significant. In case if the sign in front of the coefficients is "positive" in the VECM model, this means "overestimate". And in here, the sign to be "negative" indicates to the direction of "correction" function.

It is seen that the errors in the long-term VAR model have been corrected (adjusted) by the ratios of 10.80% and 5.13% respectively each month (period) in the short-term VECM model.

With a clearer expression, according to the equation number 2, it is understood that “long-term balance” can be reached by eliminating (recovering) 10.80% of a deviation that will happen in the producer prices (s2_ufe) each month (period). According to this, at the end of an approximately 9 months (period), long-term balance will be reached.

Again, according to equation number 3, it is understood that “long-term balance” can be reached by eliminating (recovering) each month (period) 5.13% of a deviation that will occur at the core-b consumer price index cpi (s3_tufe_cb) in short-term. According to this, at the end of an approximately 19 months (period), long-term balance will be reached.

In case if a cointegration relation exists, there must be at least one (1) directional "causality relation" among the variables. However, cointegration analysis does not show the causality, direction and degree between the exchange rate and producer- consumer inflation indicators.

3.10.6 Granger causality test

It is important to distinguish the difference between the short and long-term causality relations in the VECM Model. The error correction term refers to long term causal effects, while the delay values in independent variable indicates short-term causal effects (Love ve Chandra, 2005).

The VAR/VECM equation derived from the variables' (-1) difference level and series; *(Substituted Coefficients)*

*D(S3_TUFE_CB) = 0.133020744059*D(S1_DVZSPOT) + 0.154735784719*D(S2_UFE) - 0.0513502121008*RESID01(-1) + 0.91794183777*

Table 3. 8 : VECM Equation coefficients table.

EQUATION	3	DEPENDENT VARIABLE $\Delta s3\_tufe\_cb_t$		
Variable	EC_{t-1}	$\Delta s1\_dvzspot_{t-1}$	$\Delta s2\_ufe_{t-1}$	e_1
Coefficient	-0.05135	0.133021	0.154736	0.917942

As it is seen, in the short-term VECM equation ($s1\_dvzspot_{t-1}$) where *(s3_tufe_cb)* variable is ‘‘dependent’’, coefficient of ($s1\_dvzspot_{t-1}$) variable results as 0.133021.

In Johansen's cointegration test results, "alpha" (feedback) and "adjusting coefficients" also appear. Alpha coefficients are related to "Granger causality". Granger causality appears when alpha values differ from zero.

Table 3. 9: Double Granger causality test.

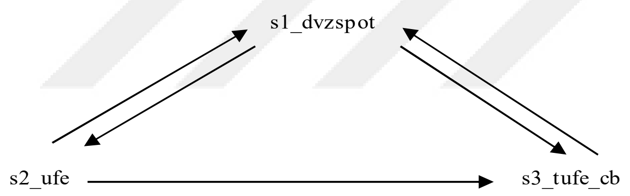
Pairwise Granger Causality Tests
Lags: 2

Null Hypothesis:	Obs	F-Statistic	Prob.
S1_DVZSPOT does not Granger Cause S3_TUFE_CB	178	3.33106	0.0381
S3_TUFE_CB does not Granger Cause S1_DVZSPOT		3.28701	0.0397
S2_UFE does not Granger Cause S3_TUFE_CB	178	8.03331	0.0005
S3_TUFE_CB does not Granger Cause S2_UFE		5.29511	0.0059
S2_UFE does not Granger Cause S1_DVZSPOT	178	3.18605	0.0438
S1_DVZSPOT does not Granger Cause S2_UFE		16.6675	2.E-07

In the Granger causality test at (Table 3.9) (Delay parameter: 2), relevant time series are approached at level values and the F statistics is considered. At significancy level of 0.05, if the zero hypothesis of "... does not Granger Cause ..." is rejected, then Granger Cause is present. In the P-value column of the table, it is seen that the null hypothesis (<0.05) (H_0) is rejected.

Table 3. 10: Granger causality test.

GRANGER CAUSALITY TEST	WALD TEST	INDEPENDENT VARIABLES	
DEPENDENT VARIABLES	s1_dvzspot	s2_ufe	s3_tufe_cb
s1_dvzspot chi-square test		7.12102	7.32154
p-value		0.02840	0.02570
t > 0.05 H0: IRREPUTABLE		H0: RED	H0: REJECTION
t < 0.05 H0: REJECTION		is cause of ufe dvzspot	tufe_cb is cause of dvzspot
s2_ufe chi-square test	26.49033		4.72048
p-valuei	0.00000		0.09440
t > 0.05 H0: IRREPUTABLE	H0: RED		H0: IRREPUTABLE
t < 0.05 H0: REJECTION	is cause of dvzspot ufe		is not cause of tufe_cb ufe
s3_tufe_cb chi-square te	6.60747	15.90442	
p-value	0.03670	0.00040	
t > 0.05 H0: IRREPUTABLE	H0: REJECTION	H0: REJECTION	
t < 0.05 H0: REJECTION	s cause of dvzspot tufe_cb	ufe is cause oftufe_cb	



In the ‘‘Granger causality test’’ at (Table 3.10) applied on the VAR model which is dormed from level values of variables’ relevant time series and chi-square *(Chi-sq)* statistics is considered. Inj the evaluation at significancy level of 0.05, if the zero hypothesis is rejected, then Granger Cause is present. In the P-value row of the table, it is seen that the null hypothesis (<0.05) (H_0) is rejected

According to this, when there is a "two-directional causality relationship" between currency rates and producer prices and core consumer prices, there is a "one-way causality connection" between the producer prices and core consumer prices which is only from producer prices towards core consumer prices.

3.10.7 Impact and response functions

After the long-term relationship structure between the variables and the causality direction related to this are revealed, the transition effect from currency to domestic prices during the period is calculated by proportiomng the cumulative coefficients of the "impact-response functions" estimated from the VAR / VECM equation model.

The impact-response function was estimated by the "Cholesky decomposition" method under certain constraints for a time frame of 24 months. The cumulative response coefficient of the price index to the exchange rate in the analysis, is estimated by proportioning the exchange rate itself to the the cumulative impact-response coefficient.

For example, to predict the transition impact coefficients to core tufe b, cumulative impact-response functions are provided from the VAR/VECM model. The reaction of the core Tufe b against a shock of one (1) standard deviation in the currency basket is proportioned to the impact that the currency gave against one (1) standard deviation shock occurred in the currency itself and the transition impact for the related period is calculated.

In (Figure 3. 4), Periodic (graphic on the left) and cumulative impact (graphic on the right) of a 1% persistent shock came to currency on Core TUFE B.

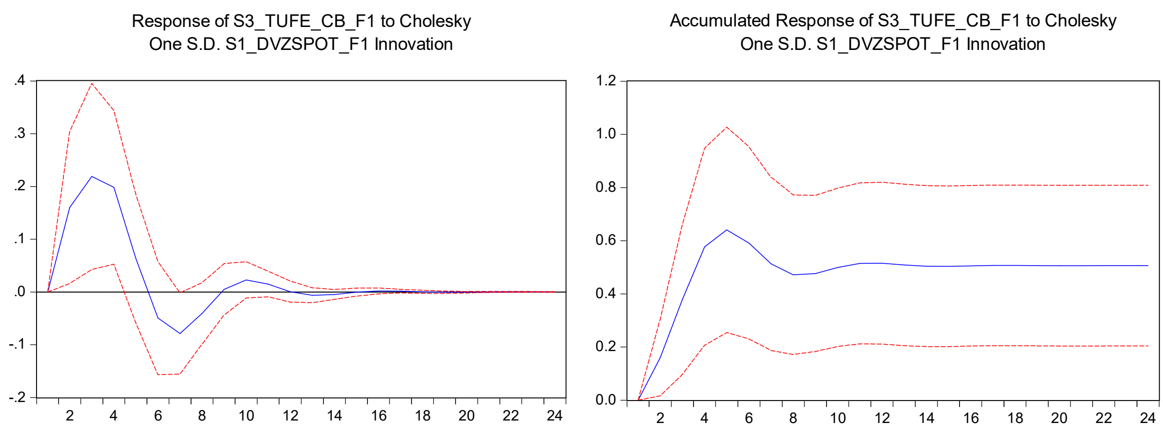


Figure 3. 4: Periodic and cumulative impact-response function result graphics.

As it can be seen from the presentation on graphics and table, transition period of exchange rate shocks towards the domestic prices follows a reflection path which is relatively increasing and decreasing.

While a 1% shock coming to the exchange rate is reflects to the core TUFE B periodically in the first few months, this reflection effect decreases symmetrically in the following periods and the transition effect disappears in great extent after 14th month.

When examined periodically, while a 1% shock to exchange rate effects the core TUFE in 16.0% amount in following 2 months, this rate reaches up to 37.89% in 3 months. As of the 6th month, while 59.14% of the shock reflects to the Core TUFE, transition of the shock is completed as 47.46% by the 9th month and 51.50% as of the 12th month. As of the 14th month, this effect normalizes at levels of 50.3% and gains stability.

As a result, 50% of a 1% exchange rate shock reflects to the prices in a period of 14 months and ends.

Table 3. 11: Table of impact-response function result values.

IMPACT-RESPONSE FUNCTION		
PERIOD (MONTH)	PERODICAL	ST-DEVIATION
1	0.0000	0.0000
2	0.1600	-0.0720
3	0.2190	-0.0882
4	0.1983	-0.0729
5	0.0635	-0.0610
6	-0.0494	-0.0537
7	-0.0787	-0.0385
8	-0.0409	-0.0292
9	0.0049	-0.0245
10	0.0229	-0.0172
11	0.0150	-0.0121
12	0.0006	-0.0100
13	-0.0064	-0.0070
14	-0.0048	-0.0046
15	-0.0004	-0.0039
16	0.0019	-0.0028
17	0.0015	-0.0017
18	0.0002	-0.0014
19	-0.0006	-0.0011
20	-0.0005	-0.0007
21	-0.0001	-0.0005
22	0.0002	-0.0004
23	0.0002	-0.0003
24	0.0000	-0.0002

IMPACT-RESPONSE FUNCTION		
PERIOD (MONTH)	CUMULATIVE	ST-DEVIATION
1	0.0000	0.0000
2	0.1600	-0.0720
3	0.3789	-0.1410
4	0.5772	-0.1855
5	0.6407	-0.1932
6	0.5914	-0.1806
7	0.5126	-0.1630
8	0.4717	-0.1501
9	0.4766	-0.1467
10	0.4995	-0.1490
11	0.5145	-0.1514
12	0.5150	-0.1522
13	0.5087	-0.1520
14	0.5039	-0.1515
15	0.5034	-0.1511
16	0.5053	-0.1510
17	0.5068	-0.1511
18	0.5070	-0.1512
19	0.5064	-0.1512
20	0.5059	-0.1512
21	0.5059	-0.1512
22	0.5060	-0.1511
23	0.5062	-0.1511
24	0.5062	-0.1512

3.10.8 Variance decomposition

The variance decomposition obtained from the dynamicg average section of the VAR / VECM Model shows the sources of the shocks as a ratio which occur on the variables themselves and other variables. It indicates the percentages of a change in the variables as sourced from itself and from other variables.

According to the results, while part of the currency in estimated error variance after a “random” shock at the ‘‘Core TUFE B’’ is 1.93% at 2nd month, this value reaches to 5.14% at 3rd month and 7.11% as of 5th month.

Table 3. 12: Table of variance decomposition result values

VARIANCE DECOMPOSITION	S3_TUFE_CB_F1			
PERIOD	S.E.	S3_TUFE_CB_F1	S1_DVZSPOT_F1	S2_UFE_F1
1	0.9377	100.0000	0.0000	0.0000
2	1.1490	97.1266	1.9379	0.9355
3	1.1955	89.7199	5.1444	5.1358
4	1.2611	86.9194	7.0963	5.9843
5	1.2821	87.0757	7.1116	5.8128

VARIANCE DECOMPOSITION	S1_DVZSPOT_F1			
PERIOD	S.E.	S3_TUFE_CB_F1	S1_DVZSPOT_F1	S2_UFE_F1
1	0.9377	0.3196	99.6804	0.0000
2	1.1490	1.6725	97.5349	0.7927
3	1.1955	1.6573	95.1726	3.1701
4	1.2611	1.7464	94.9126	3.3409
5	1.2821	1.8388	94.7949	3.3664

VARIANCE DECOMPOSITION	S2_UFE_F1			
PERIOD	S.E.	S3_TUFE_CB_F1	S1_DVZSPOT_F1	S2_UFE_F1
1	0.9377	2.7043	19.7909	77.5049
2	1.1490	2.1782	40.5190	57.3028
3	1.1955	2.1480	42.8100	55.0419
4	1.2611	2.4997	42.7739	54.7264
5	1.2821	2.5794	42.6605	54.7601

4 MODEL APPLICATION SOLUTION

4.1 The Impacts of Exchange Rate Shocks on Insurance Sector

When the insurance products are compared to industrial products, it will be seen that the insurance services have different features. The main difference is that the insurance service is actually a product that is "first sold, then produced". Release of the product happens before the completion stage. That is, a commitment and acceptance of a premium payment for the compensation of a possible future damage is in question.

The “future” term here brings an “uncertainty” with it;

The additional load that will bring to the compensation costs of "random exchange rate shocks" that will be experienced in the period up to the moment when the compensation obligation becomes an issue which arises from the "1 year" policy of which its premium is received “in advance” at the moment of sale. Here, even though the insurance company has considered the "expected inflation" when creating the pricing, the unexpected exchange rate shocks cause inflation to diverge. Accordingly, the company's probable future "Realised Loss" amount will deviate from the initial estimated values. A more costful and "more expensive" payment In the future is funded from a relatively "cheap" premium pricing in the past.

While the exchange rate shock modifies the general level of prices by its transition effect, besides the expected inflation in the current policy pricing list, also a need for reflection of exchange rate shock effect to the prices "at the right time" comes up.

4.1.1 Exchange rate shock: average claim cost increase

In terms of the obligations of the insurance sector, especially the risks arising from the car insurance policies show a more “apparent” frequency when compared to the other damage types.

Example; For the case in (Table 4.1), consider the car insurance policy outstanding claim reserves triangle prepared by Turkish insurance companies usually in 3 month periods (quarterly) using chain ladder method.

Top half of the table: Reflects the data of "Backdated" (actualized) and periodically based car insurance policy outstanding damages’ sum (equivalent). Relevant values include the information of average damage dimension based on damage file which is a function of the damage frequency (periodical number) and the damage severity. Findings about the data characteristics in the table can be listed as follows;

a. "Compensation process" of the car insurance policy damages are completed in great amount the first "2 months" period as of the development periods.
b. Frequency of the car insurance policy damages shows some certain numerical characteristics (averages).
c. Frequency of the car insurance policy damages is quite high when compared to the other damage types.

Down half of the table: Indicates the actualized damage equivalents' estimated amonts that the company will be liable for related to "future date"quartered periods which are simulated according to probability distribution.

Table 4. 1: Example of actualized damage chain ladder.

Actual'zed	Past Damage Data	Development periods							
Year	0	1	2	3	4	5	6	7	8
2016 Q1	34,847,808	4,610,345	1,785,700	1,276,556	1,173,407	674,134	441,021	422,362	459,233
2016 Q2	33,461,899	4,394,197	1,938,356	1,296,635	1,178,209	1,084,847	1,047,596	1,013,746	
2016 Q3	35,737,535	3,994,137	1,548,130	1,279,782	1,193,038	1,345,879	1,383,921		
2016 Q4	33,692,264	4,913,762	1,991,117	1,291,960	1,150,775	1,120,543			
2017 Q1	36,134,254	5,029,575	1,673,288	2,667,121	2,627,606				
2017 Q2	34,819,755	7,674,657	2,191,616	1,738,225					
2017 Q3	70,084,180	28,559,694	19,264,671						
2017 Q4	46,199,464	30,168,958							
TOTAL	1,158,656,004	193,470,355	68,576,181	36,239,415	29,049,797	24,903,880	23,223,212	24,047,656	22,475,121

Est'mated Amounts of Outstand'ng Damage Reserves on Future Quarter Periods' Basis.

2018 Q1	34,004,970
2018 Q2	36,226,240
2018 Q3	50,300,833
2018 Q4	39,680,154

Because of the car insurance damage portfolio's "Poisson distribution" characteristics and since it shows high damage frequency features, approximate estimation of the "outstanding damage equivalents" related to future periods under the assumption that there are no unusual changes in the "business model" of the insurance company becomes quite possible together with the "future time consideration"

Situation of an exchange rate shock in economy; Assume that a 4.51% "upwards directed", "sudden" and "persistent" exchange rate shock is experienced as in the example of exchange rates in the 1^{st} quarter period in Table 4.1.

Since the "average damage file cost" related to the policy that the insurance company "has received its premium previously" and will be liable to compensate in the "future" periods will "rise" because the inflation transitivity, the company's "total amount of actualized damages" will grow in the same proportion.

The insurance company will fall in a situation to write a "technical loss" from the received portfolios "before the exchange rate shock" and from the compensation payments "after the exchange rate shock" of the policy premiums on the risk groups basis.

4.1.2 Solution suggestion for post exchange rate shock

Any "nominal change" is impossible over the actualized policy receipts and damage compensation amounts for the periods after the exchange rate shock

However, as of the future 3 months period, a difference will occur against the insurance which is between the "total amount of assumed actualized damages" and the "total amount of actualized damages" after the exchange rate shock.

The "increase load" that a single exchange rate increase formed in (Table 4.2) will create on the " damage equivalent reserve" calculated with the" damage triangles" in (Table 4.1) is shown.

On the upper part of (Table 4. 2), it is assumed that a 4.51% positive directed change from a currency level of 4.2202 to 4.44108 is experienced at the currency basket during a period of 1 month.

The reflection time and amount of this change to te overall level of domestic prices in the next 11 months is modeled over the VAR/VECM equation and the impact-response function based on that. Pass-throughimpact is transformed into monthly coefficients.

The "deviation" that the sudden and persistent exchange rate shock will create in "months" basis on the index time series which is assumed previously according to TUIK’s expected inflation is re-estimated and updated.

On the lower part of (Table 4. 2), the dimension of the liability increase that is formed by the exchange rate is calculated in currency type. The process steps related to this are respectively;

The "actualized damage reserves" which is estimated over TL currency is increased in the amount to reflect the exchange rate shock over calculated monthly coefficients.

Table 4.2: Reflection of the inflation pass-throughto the damage pricing.

Impulse Reaction Function	INFLATION PASS-THROUGH				PRE-EXCHANGE RATE SHOCK		POST-EXCHANGE RATE SHOCK	
Period (Month)	PERIODICAL	ST-DEVIATON	CUMULATIVE	ST-DEVIATON	CPI INDEX	CPI SO YOY %	CPI INDEX	CPI SS YOY %
28.02.18					327.33			
31.03.18	0.0000	0.0000	0.0000	0.0000	330.64	10.40	330.64	10.40
30.04.18	0.1600	-0.0720	0.1600	-0.0720	333.09	10.26	333.40	10.37
31.05.18	0.2190	-0.0882	0.3789	-0.1410	334.44	9.60	335.19	9.85
30.06.18	0.1983	-0.0729	0.5772	-0.1855	339.61	9.87	340.77	10.25
31.07.18	0.0635	-0.0610	0.6407	-0.1932	342.87	10.40	344.16	10.82
31.08.18	-0.0494	-0.0537	0.5914	-0.1806	343.56	10.89	344.75	11.28
30.09.18	-0.0787	-0.0385	0.5126	-0.1630	346.71	11.76	347.75	12.10
31.10.18	-0.0409	-0.0292	0.4717	-0.1501	348.59	11.80	349.56	12.11
30.11.18	0.0049	-0.0245	0.4766	-0.1467	351.07	11.87	352.06	12.19
31.12.18	0.0229	-0.0172	0.4995	-0.1490	356.29	11.28	357.34	11.60
31.01.19	0.0150	-0.0121	0.5145	-0.1514	359.48	10.60	360.56	10.93
28.02.19	0.0006	-0.0100	0.5150	-0.1522	362.91	10.87	364.01	11.20
31.03.19	-0.0064	-0.0070	0.5087	-0.1520	365.60	10.57	366.70	10.90
30.04.19	-0.0048	-0.0046	0.5039	-0.1515	368.28	10.56	369.37	10.89
31.05.19	-0.0004	-0.0039	0.5034	-0.1511	370.98	10.92	372.08	11.25
30.06.19	0.0019	-0.0028	0.5053	-0.1510	373.69	10.03	374.80	10.36
31.07.19	0.0015	-0.0017	0.5068	-0.1511	376.43	9.79	377.55	10.12
31.08.19	0.0002	-0.0014	0.5070	-0.1512	379.19	10.37	380.32	10.70
30.09.19	-0.0006	-0.0011	0.5064	-0.1512	381.96	10.17	383.10	10.50
31.10.19	-0.0005	-0.0007	0.5059	-0.1512	384.77	10.38	385.91	10.70
30.11.19	-0.0001	-0.0005	0.5059	-0.1512	387.58	10.40	388.73	10.73
31.12.19	0.0002	-0.0004	0.5060	-0.1511	390.42	9.58	391.58	9.90
31.01.20	0.0002	-0.0003	0.5062	-0.1511	393.28	9.40	394.45	9.73
29.02.20	0.0000	-0.0002	0.5062	-0.1512	396.16	9.12	397.33	9.45

EQUATION	VECM	Dependent Variable		$\Delta s3\_tufe\_ch_t$
Variable	EC_{t-1}	$\Delta s1\_dvzspot_{t-1}$	$\Delta s2\_ufe_{t-1}$	e_1
Coefficient	-0.05135	0.1330	0.1547	0.9179

EXCHANGE RATE		INDEX	LOG-DELTA	Beginning of Period
02.18	4.2202	s1_dvzspot	0.00588	02.18
03.18	4.4108			

		ACTUALIZED DAMAGE EQUIVALENT		
DATE	PERIOD	INITIAL ESTIMATION	SHOCK ADDED	INCREASE
31/03/18	Q1	34,004,970.35	34,004,970.35	0.00
30/06/18	Q2	36,226,239.66	36,349,113.66	122,874.00
30/09/18	Q3	50,300,832.75	50,452,348.42	151,515.67
31/12/18	Q4	39,680,153.50	39,796,620.00	116,466.49
		160,212,196.26	160,603,052.43	390,856.17

<u>Solution suggestion related to the impact:</u> Solution suggestion in this regard puts forward the change in damage amount magnitude arising from the exchange rate shock numerically as of the future periods.

Since it will be seen in the lowest part of the study, the increase impact of a single exchange rate shock of 4.51% for one year period on the total amount of damage equivalent which is actualized in magnitude of approximately 160 million TL is at 390,000 TL level.

First stage of the solution suggestion; It is revealing the liablity increase that will occur after the exchange rate shock. Afterwards, as the exchange rate shocks are experienced, the insurance companies must quickly (dynamically) calculate the impacts of these, make tariff updates at variable intervals (after the formation of the exchange rate) and reflect the impacts of these changes in their tariffs.

Second stage of the solution suggestion; If the exchange rate shocks' inflation pass-throughimpact is considered in process terms, since the reflection rate (share) of a 1% shock to the core TUFE in the following 2nd month is realized in 16.0% rate and yhis rate reaches to 37.89% at 3rd month indicate that the process work quickly.

For this reason, it is important for the insurance companies to reflect the tariff updates to their prices without delay at the periods after the exchange rate shocks.

In practice, it is observed that the insurance companies carry out calculations over the forward currency or next period's currency estimations for price updates after realized exchange rate shocks.

Properly modeling the inflation pass-throughchannels of exchange rate movements and dynamically reflecting them to prices will open the way to create healthier damage/ premium rates for insurance companies.

As an example: A "yearly (year-on-year)" forecast of expected inflation with all relevant information at the market (including the exchange rate shocks experienced in recent past) at the first stage before the sudden exchange rate shock must be available in our hands ;(Figure 4. 2) and (Figure 4.3).

Data in (Figure 4. 2 ve Figure 4. 3) indicates the "past" and "rxpected" inflations.

The coefficients created from the "patterned" "impact-response" function in (Table 4.2) model the "exchange rate shock" sourced inflation transitivity.

The "estimated"data in (Figure 4.2) reflects the "patterned" "impact-response" function in (Figure 4.2).

The "TUFE inflation price index forecast" data (Figure 4.2) which is "forwarded" by predicting previously is updated as to include this impact at the moment when a new sudden and persistent exchange rate shock (Figure 4.3 and Figure 4.3) is experienced.

In (Figure 4. 5), "yearly inflation forecast" which is estimated before the exchange rate shock and "yearly inflation forecast" difference that is updated after the exchange rate shock accordingly are observed on the graphics.

4.2 Conclusion

Re-estimated inflation index which includes the exchange rate shock has been transformed into a form that can be used by the actuarial department of the insurance company to calculate the net risk premium (damage premium) for the insurance policy risk groups pricing process.

In practice, "conventional" or usually done in a practical way should be; after an exchange rate shock, to try "replicating manually the "inflational" impact of an exchange rate shock experienced in the near future, by forwardly updating the “net risk premium” pricing in the near future with a change rate based on "forecast" or "forward" exchange rates. Or waiting for market update analyst reports on expected inflation may also help the insurers to view theie future in terms of pricing, but time-loss occurs during this process.

To execute "forecasting" over a "structural model" such as in this thesis study will provide a positive added value for actuarial and financial departments of insurance companies in terms of "real time" and "correct" pricing.

The model has features that are open to development in itself. For example, a more precise calculation can be achieved by conducting the model on 4 variables rather than 3 as done in this study. In addition, for the insurance sector particularly, instead of TUFE Core B which is the the final variant of the inflation production model in this study, more "focussed and specialized" numerical results can be obtained by articulating the " average damage file cost" as time series of the overall insurance sector or the relevant company.

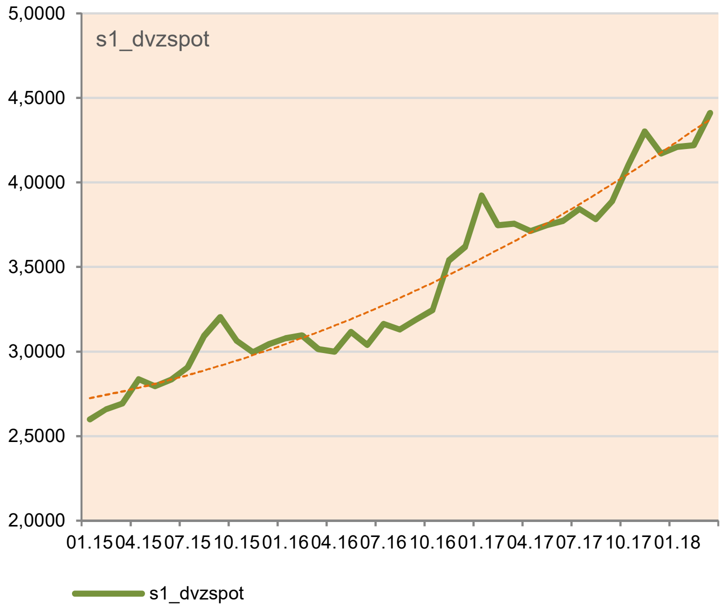


Figure 4. 1 : Foreign exchange basket time series..

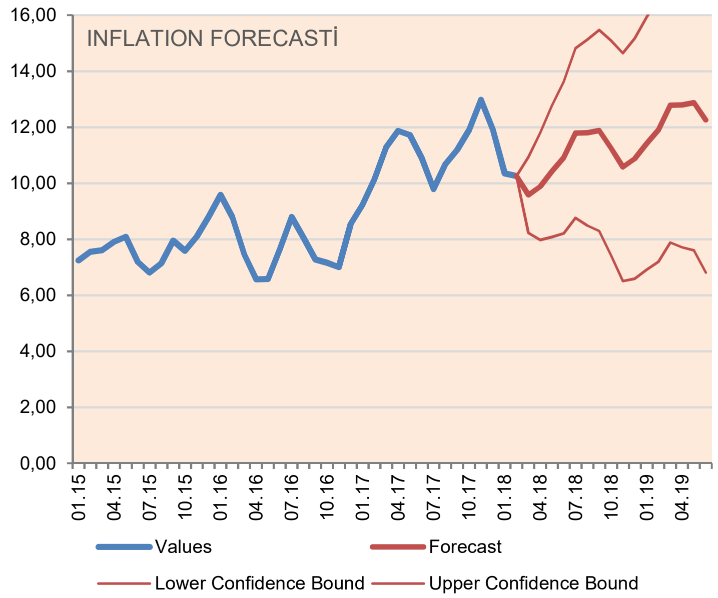


Figure 4. 2: Seasonal corrected inflation trend forecast.

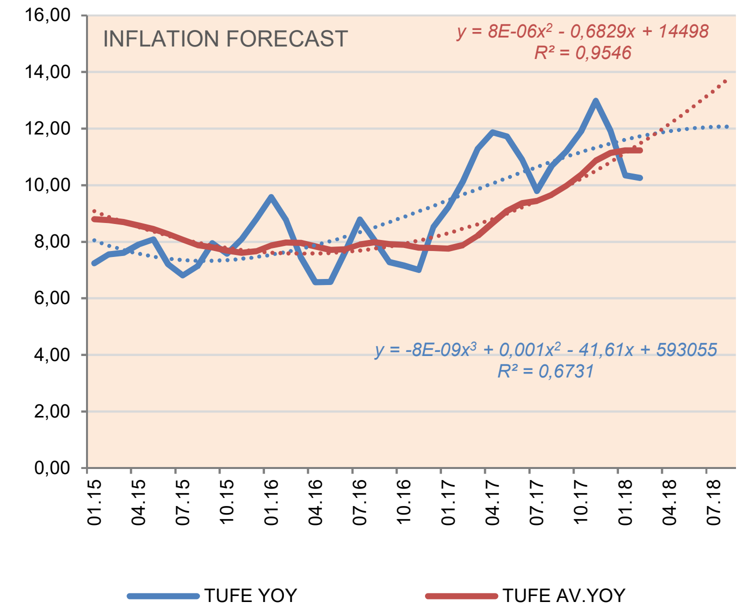


Figure 4. 3: Inflation regression forecast.

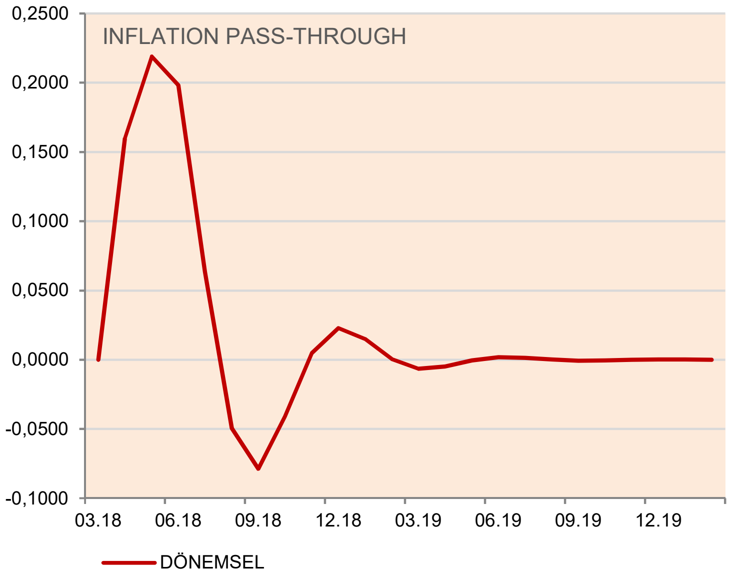


Figure 4. 4: Inflation pass-through trend (periodical).

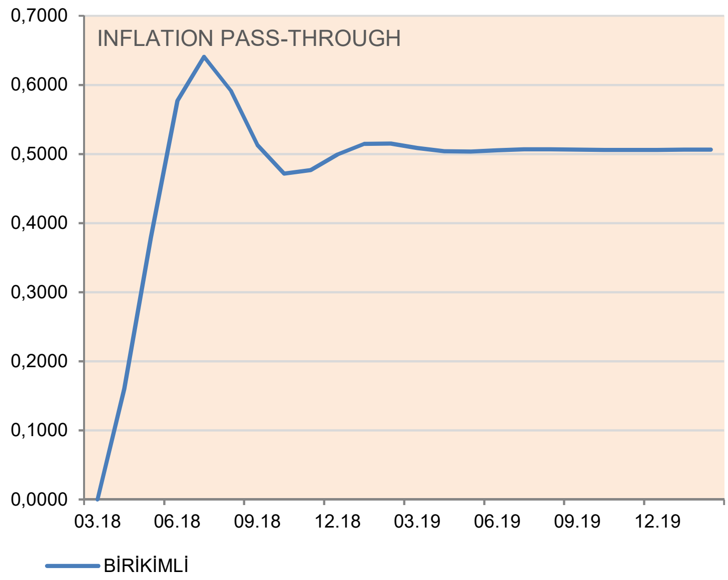


Figure 4. 4: Inflation pass-through trend (cumulative).

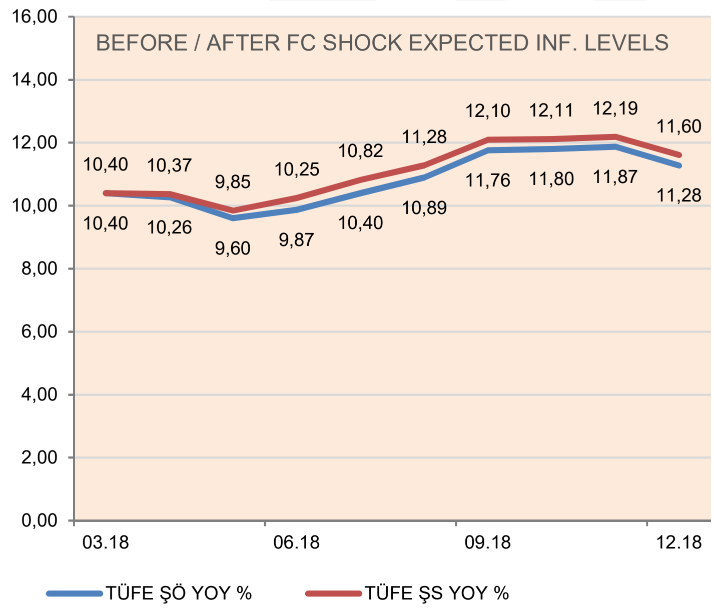


Figure 4. 5: Deviation impact of a single exchange rate shock on 1 year inflation forecast.

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ANNEXES

Annex A 1, Time series used in the study carried out Chapter 3.

date	s1_dvzspot	s2_ufe	s3_tufe_cb	s1_dvzspot_f1	s2_ufe_f1	s3_tufe_cb_f1	s1_dvzspot_log	s2_ufe_log	s3_tufe_cb_log
01.01.03	1.7100	96.0700	94.4600	NA	NA	NA	0.5365	4.5651	4.5482
01.02.03	1.6605	98.1800	95.2300	-0.0495	2.1100	0.7700	0.5071	4.5868	4.5563
01.03.03	1.7875	99.8800	96.1200	0.1270	1.7000	0.8900	0.5808	4.6040	4.5656
01.04.03	1.6570	99.0700	97.6800	-0.1305	-0.8100	1.5600	0.5050	4.5958	4.5817
01.05.03	1.5503	98.1000	98.9700	-0.1067	-0.9700	1.2900	0.4384	4.5860	4.5948
01.06.03	1.5215	97.8600	99.9800	-0.0288	-0.2400	1.0100	0.4197	4.5835	4.6050
01.07.03	1.5150	98.2200	100.4900	-0.0065	0.3600	0.5100	0.4154	4.5872	4.6101
01.08.03	1.4624	98.7500	101.2000	-0.0526	0.5300	0.7100	0.3801	4.5926	4.6171
01.09.03	1.5055	98.6600	102.8900	0.0431	-0.0900	1.6900	0.4091	4.5917	4.6337
01.10.03	1.5986	99.7000	103.8000	0.0931	1.0400	0.9100	0.4691	4.6022	4.6425
01.11.03	1.6079	101.8200	104.5200	0.0093	2.1200	0.7200	0.4749	4.6232	4.6494
01.12.03	1.5871	102.3000	104.6500	-0.0208	0.4800	0.1300	0.4619	4.6279	4.6506
01.01.04	1.4945	106.1500	105.5100	-0.0926	3.8500	0.8600	0.4018	4.6649	4.6588
01.02.04	1.4865	106.3800	105.8400	-0.0080	0.2300	0.3300	0.3964	4.6670	4.6619
01.03.04	1.4640	107.0000	105.8000	-0.0225	0.6200	-0.0400	0.3812	4.6728	4.6616
01.04.04	1.5591	109.4400	106.5100	0.0951	2.4400	0.7100	0.4441	4.6954	4.6682
01.05.04	1.6584	114.4000	107.7500	0.0993	4.9600	1.2400	0.5059	4.7397	4.6798
01.06.04	1.6465	115.3200	108.7900	-0.0119	0.9200	1.0400	0.4987	4.7477	4.6894
01.07.04	1.6169	114.4600	109.2500	-0.0296	-0.8600	0.4600	0.4805	4.7402	4.6936
01.08.04	1.6654	115.5800	109.8500	0.0485	1.1200	0.6000	0.5101	4.7500	4.6991
01.09.04	1.6840	116.4100	111.0600	0.0186	0.8300	1.2100	0.5212	4.7571	4.7101
01.10.04	1.6547	119.2800	112.9100	-0.0293	2.8700	1.8500	0.5036	4.7815	4.7266
01.11.04	1.6678	119.2800	114.2800	0.0131	0.0000	1.3700	0.5115	4.7815	4.7387
01.12.04	1.5951	118.0000	114.5500	-0.0727	-1.2800	0.2700	0.4669	4.7707	4.7410
01.01.05	1.5360	117.5100	115.1600	-0.0591	-0.4900	0.6100	0.4292	4.7665	4.7463
01.02.05	1.4895	117.6400	114.7200	-0.0465	0.1300	-0.4400	0.3984	4.7676	4.7425
01.03.05	1.5525	119.1300	114.7600	0.0630	1.4900	0.0400	0.4399	4.7802	4.7428
01.04.05	1.5898	120.5600	116.1300	0.0373	1.4300	1.3700	0.4636	4.7921	4.7547
01.05.05	1.5205	120.8000	118.0800	-0.0693	0.2400	1.9500	0.4190	4.7941	4.7714
01.06.05	1.4748	120.2300	118.9900	-0.0457	-0.5700	0.9100	0.3885	4.7894	4.7790
01.07.05	1.4687	119.3300	118.2600	-0.0061	-0.9000	-0.7300	0.3844	4.7819	4.7729
01.08.05	1.4975	120.5700	118.1600	0.0288	1.2400	-0.1000	0.4038	4.7922	4.7720
01.09.05	1.4840	121.5100	118.7500	-0.0135	0.9400	0.5900	0.3947	4.8000	4.7770
01.10.05	1.4860	122.3400	120.5000	0.0020	0.8300	1.7500	0.3961	4.8068	4.7916
01.11.05	1.4775	121.1900	121.4200	-0.0085	-1.1500	0.9200	0.3904	4.7974	4.7993
01.12.05	1.4705	121.1400	121.7900	-0.0070	-0.0500	0.3700	0.3856	4.7969	4.8023
01.01.06	1.4658	123.5100	121.7600	-0.0047	2.3700	-0.0300	0.3824	4.8163	4.8021
01.02.06	1.4398	123.8300	120.8000	-0.0260	0.3200	-0.9600	0.3645	4.8189	4.7941
01.03.06	1.4873	124.1400	120.6200	0.0475	0.3100	-0.1800	0.3970	4.8214	4.7926
01.04.06	1.4883	126.5400	122.4000	0.0010	2.4000	1.7800	0.3976	4.8406	4.8073
01.05.06	1.7924	130.0500	124.9600	0.3041	3.5100	2.5600	0.5836	4.8679	4.8280
01.06.06	1.8023	135.2800	126.3700	0.0099	5.2300	1.4100	0.5891	4.9073	4.8392
01.07.06	1.6980	136.4500	126.8700	-0.1043	1.1700	0.5000	0.5295	4.9160	4.8432
01.08.06	1.6688	135.4300	127.3100	-0.0292	-1.0200	0.4400	0.5121	4.9085	4.8466
01.09.06	1.7123	135.1100	129.1300	0.0435	-0.3200	1.8200	0.5378	4.9061	4.8608
01.10.06	1.6583	135.7300	131.4800	-0.0540	0.6200	2.3500	0.5058	4.9107	4.8789
01.11.06	1.6883	135.3300	132.5100	0.0300	-0.4000	1.0300	0.5237	4.9077	4.8867
01.12.06	1.6416	135.1600	132.6200	-0.0467	-0.1700	0.1100	0.4957	4.9065	4.8875
01.01.07	1.6255	135.0900	132.1700	-0.0161	-0.0700	-0.4500	0.4858	4.9059	4.8841
01.02.07	1.6363	136.3700	132.0200	0.0108	1.2800	-0.1500	0.4924	4.9154	4.8830
01.03.07	1.6143	137.7000	132.6600	-0.0220	1.3300	0.6400	0.4789	4.9251	4.8878
01.04.07	1.6123	138.8000	134.4900	-0.0020	1.1000	1.8300	0.4777	4.9330	4.9015
01.05.07	1.5469	139.3400	136.5200	-0.0654	0.5400	2.0300	0.4363	4.9369	4.9165
01.06.07	1.5375	139.1900	137.3100	-0.0094	-0.1500	0.7900	0.4302	4.9358	4.9222
01.07.07	1.5164	139.2800	136.4500	-0.0211	0.0900	-0.8600	0.4163	4.9365	4.9160
01.08.07	1.5361	140.4700	135.8800	0.0197	1.1900	-0.5700	0.4292	4.9450	4.9118
01.09.07	1.4583	141.9000	137.0600	-0.0778	1.4300	1.1800	0.3773	4.9551	4.9204
01.10.07	1.4293	141.7100	139.3800	-0.0290	-0.1900	2.3200	0.3572	4.9538	4.9372
01.11.07	1.4588	142.9800	140.9400	0.0295	1.2700	1.5600	0.3776	4.9627	4.9483
01.12.07	1.4402	143.1900	141.3600	-0.0186	0.2100	0.4200	0.3648	4.9642	4.9513

ANNEX. A2. Time series used in the study carried out Chapter 3 (continue)

date	s1_dvzspot	s2_ufe	s3_tufe_cb	s1_dvzspot_f1	s2_ufe_f1	s3_tufe_cb_f1	s1_dvzspot_log	s2_ufe_log	s3_tufe_cb_log
01.01.08	1.4543	143.8000	140.6100	0.0141	0.6100	-0.7500	0.3745	4.9684	4.9460
01.02.08	1.5351	147.4800	140.6000	0.0808	3.6800	-0.0100	0.4286	4.9937	4.9459
01.03.08	1.7255	152.1600	142.4300	0.1904	4.6800	1.8300	0.5455	5.0249	4.9589
01.04.08	1.6333	159.0000	146.0700	-0.0922	6.8400	3.6400	0.4906	5.0689	4.9841
01.05.08	1.5559	162.3700	149.9500	-0.0774	3.3700	3.8800	0.4421	5.0899	5.0103
01.06.08	1.5759	162.9000	151.6200	0.0200	0.5300	1.6700	0.4548	5.0931	5.0214
01.07.08	1.4861	164.9300	150.9600	-0.0898	2.0300	-0.6600	0.3962	5.1055	5.0170
01.08.08	1.4597	161.0700	150.7200	-0.0264	-3.8600	-0.2400	0.3782	5.0818	5.0154
01.09.08	1.5276	159.6300	151.4500	0.0679	-1.4400	0.7300	0.4237	5.0729	5.0203
01.10.08	1.7457	160.5400	153.3300	0.2181	0.9100	1.8800	0.5572	5.0785	5.0326
01.11.08	1.7813	160.4900	154.3100	0.0356	-0.0500	0.9800	0.5773	5.0782	5.0390
01.12.08	1.8407	154.8000	153.8600	0.0594	-5.6900	-0.4500	0.6101	5.0421	5.0360
01.01.09	1.8766	155.1600	153.1500	0.0359	0.3600	-0.7100	0.6295	5.0445	5.0314
01.02.09	1.9298	156.9700	152.0800	0.0532	1.8100	-1.0700	0.6574	5.0561	5.0244
01.03.09	1.9352	157.4300	151.2300	0.0054	0.4600	-0.8500	0.6602	5.0590	5.0188
01.04.09	1.8562	158.4500	152.3700	-0.0790	1.0200	1.1400	0.6185	5.0654	5.0263
01.05.09	1.8544	158.3700	154.4900	-0.0018	-0.0800	2.1200	0.6176	5.0649	5.0401
01.06.09	1.8520	159.8600	155.1200	-0.0024	1.4900	0.6300	0.6163	5.0743	5.0442
01.07.09	1.7841	158.7400	155.1500	-0.0679	-1.1200	0.0300	0.5789	5.0673	5.0444
01.08.09	1.8263	159.4000	154.7200	0.0422	0.6600	-0.4300	0.6023	5.0714	5.0416
01.09.09	1.8286	160.3800	155.1500	0.0023	0.9800	0.4300	0.6036	5.0775	5.0444
01.10.09	1.8640	160.8400	158.1100	0.0354	0.4600	2.9600	0.6227	5.0804	5.0633
01.11.09	1.9103	162.9200	159.0800	0.0463	2.0800	0.9700	0.6473	5.0933	5.0694
01.12.09	1.8259	163.9800	158.7500	-0.0844	1.0600	-0.3300	0.6021	5.0997	5.0673
01.01.10	1.7867	164.9400	158.2900	-0.0392	0.9600	-0.4600	0.5804	5.1056	5.0644
01.02.10	1.8281	167.6800	157.9900	0.0414	2.7400	-0.3000	0.6033	5.1221	5.0625
01.03.10	1.7860	170.9400	158.8100	-0.0421	3.2600	0.8200	0.5800	5.1413	5.0677
01.04.10	1.7356	174.9600	160.2400	-0.0504	4.0200	1.4300	0.5514	5.1646	5.0767
01.05.10	1.7554	172.9500	162.2100	0.0198	-2.0100	1.9700	0.5627	5.1530	5.0889
01.06.10	1.7612	172.0800	162.1900	0.0058	-0.8700	-0.0200	0.5660	5.1480	5.0888
01.07.10	1.7371	171.8100	161.6600	-0.0241	-0.2700	-0.5300	0.5522	5.1464	5.0855
01.08.10	1.7314	173.7900	160.9100	-0.0057	1.9800	-0.7500	0.5489	5.1578	5.0808
01.09.10	1.7098	174.6700	160.9900	-0.0216	0.8800	0.0800	0.5364	5.1629	5.0813
01.10.10	1.7156	176.7800	162.8800	0.0058	2.1100	1.8900	0.5398	5.1749	5.0930
01.11.10	1.7287	176.2300	164.1800	0.0131	-0.5500	1.3000	0.5474	5.1718	5.1010
01.12.10	1.8057	178.5400	164.2900	0.0770	2.3100	0.1100	0.5909	5.1848	5.1016
01.01.11	1.9012	182.7500	164.2100	0.0955	4.2100	-0.0800	0.6425	5.2081	5.1011
01.02.11	1.9022	185.9000	164.6500	0.0010	3.1500	0.4400	0.6430	5.2252	5.1038
01.03.11	1.8671	188.1700	165.5900	-0.0351	2.2700	0.9400	0.6244	5.2373	5.1095
01.04.11	1.8859	189.3200	167.9500	0.0188	1.1500	2.3600	0.6344	5.2434	5.1237
01.05.11	1.9439	189.6100	170.5500	0.0580	0.2900	2.6000	0.6647	5.2450	5.1390
01.06.11	1.9878	189.6200	171.4900	0.0439	0.0100	0.9400	0.6870	5.2450	5.1445
01.07.11	2.0601	189.5700	171.3400	0.0723	-0.0500	-0.1500	0.7228	5.2448	5.1436
01.08.11	2.0909	192.9100	171.6500	0.0308	3.3400	0.3100	0.7376	5.2622	5.1455
01.09.11	2.1760	195.8900	172.9300	0.0851	2.9800	1.2800	0.7775	5.2776	5.1529
01.10.11	2.1125	199.0300	175.8700	-0.0635	3.1400	2.9400	0.7479	5.2935	5.1697
01.11.11	2.1422	200.3200	178.1100	0.0297	1.2900	2.2400	0.7618	5.2999	5.1824
01.12.11	2.1683	202.3300	178.3200	0.0261	2.0100	0.2100	0.7739	5.3099	5.1836
01.01.12	2.0500	203.1000	178.5900	-0.1183	0.7700	0.2700	0.7178	5.3137	5.1851
01.02.12	2.0397	202.9100	178.5900	-0.0103	-0.1900	0.0000	0.7128	5.3128	5.1851
01.03.12	2.0810	203.6400	179.3000	0.0413	0.7300	0.7100	0.7328	5.3164	5.1891
01.04.12	2.0415	203.8100	182.4200	-0.0395	0.1700	3.1200	0.7137	5.3172	5.2063
01.05.12	2.0882	204.8900	184.5800	0.0467	1.0800	2.1600	0.7363	5.3225	5.2181
01.06.12	2.0505	201.8300	185.3800	-0.0377	-3.0600	0.8000	0.7181	5.3074	5.2224
01.07.12	2.0019	201.2000	185.1300	-0.0486	-0.6300	-0.2500	0.6941	5.3043	5.2211
01.08.12	2.0520	201.7100	184.8800	0.0501	0.5100	-0.2500	0.7188	5.3068	5.2197
01.09.12	2.0540	203.7900	185.4000	0.0020	2.0800	0.5200	0.7198	5.3171	5.2225
01.10.12	2.0582	204.1500	187.7900	0.0042	0.3600	2.3900	0.7218	5.3189	5.2353
01.11.12	2.0541	207.5400	189.5200	-0.0041	3.3900	1.7300	0.7198	5.3353	5.2445
01.12.12	2.0676	207.2900	189.9100	0.0135	-0.2500	0.3900	0.7264	5.3341	5.2466

ANNEX. A3. Time series used in the study carried out Chapter 3 (continue).

date	s1_dvzspot	s2_ufe	s3_tufe_cb	s1_dvzspot_f1	s2_ufe_f1	s3_tufe_cb_f1	s1_dvzspot_log	s2_ufe_log	s3_tufe_cb_log
01.01.13	2.0739	206.9100	189.8300	0.0063	-0.3800	-0.0800	0.7294	5.3323	5.2461
01.02.13	2.0737	206.6500	189.8300	-0.0002	-0.2600	0.0000	0.7293	5.3310	5.2461
01.03.13	2.0653	208.3300	190.6500	-0.0084	1.6800	0.8200	0.7253	5.3391	5.2504
01.04.13	2.0762	207.2700	193.3700	0.0109	-1.0600	2.7200	0.7305	5.3340	5.2646
01.05.13	2.1571	209.3400	195.8700	0.0809	2.0700	2.5000	0.7688	5.3440	5.2775
01.06.13	2.2184	212.3900	196.7100	0.0613	3.0500	0.8400	0.7968	5.3584	5.2817
01.07.13	2.2539	214.5000	197.1500	0.0355	2.1100	0.4400	0.8127	5.3683	5.2840
01.08.13	2.3661	214.5900	197.4300	0.1122	0.0900	0.2800	0.8612	5.3687	5.2854
01.09.13	2.3745	216.4800	198.9100	0.0084	1.8900	1.4800	0.8648	5.3775	5.2929
01.10.13	2.3553	217.9700	202.0800	-0.0192	1.4900	3.1700	0.8567	5.3844	5.3087
01.11.13	2.3818	219.3100	203.3200	0.0265	1.3400	1.2400	0.8679	5.3905	5.3148
01.12.13	2.5512	221.7400	203.4100	0.1694	2.4300	0.0900	0.9366	5.4015	5.3152
01.01.14	2.6579	229.1000	204.4500	0.1067	7.3600	1.0400	0.9775	5.4342	5.3203
01.02.14	2.6271	232.2700	206.2200	-0.0308	3.1700	1.7700	0.9659	5.4479	5.3289
01.03.14	2.5451	233.9800	208.8000	-0.0820	1.7100	2.5800	0.9342	5.4552	5.3414
01.04.14	2.5227	234.1800	212.8100	-0.0224	0.2000	4.0100	0.9253	5.4561	5.3604
01.05.14	2.4788	232.9600	215.7800	-0.0439	-1.2200	2.9700	0.9078	5.4509	5.3743
01.06.14	2.5098	233.0900	216.7100	0.0310	0.1300	0.9300	0.9202	5.4514	5.3786
01.07.14	2.5058	234.7900	217.6300	-0.0040	1.7000	0.9200	0.9186	5.4587	5.3828
01.08.14	2.5022	235.7800	217.8900	-0.0036	0.9900	0.2600	0.9172	5.4629	5.3840
01.09.14	2.5782	237.7900	218.7100	0.0760	2.0100	0.8200	0.9471	5.4714	5.3877
01.10.14	2.4984	239.9700	221.9400	-0.0798	2.1800	3.2300	0.9157	5.4805	5.4024
01.11.14	2.4924	237.6500	223.4300	-0.0060	-2.3200	1.4900	0.9132	5.4708	5.4091
01.12.14	2.5803	235.8400	222.8400	0.0879	-1.8100	-0.5900	0.9479	5.4632	5.4065
01.01.15	2.5987	236.6100	223.5800	0.0184	0.7700	0.7400	0.9550	5.4664	5.4098
01.02.15	2.6587	239.4600	223.6200	0.0600	2.8500	0.0400	0.9778	5.4784	5.4099
01.03.15	2.6931	241.9700	224.9800	0.0344	2.5100	1.3600	0.9907	5.4888	5.4160
01.04.15	2.8368	245.4200	228.9900	0.1437	3.4500	4.0100	1.0427	5.5030	5.4337
01.05.15	2.7955	248.1500	232.8500	-0.0413	2.7300	3.8600	1.0280	5.5140	5.4504
01.06.15	2.8341	248.7800	233.6500	0.0386	0.6300	0.8000	1.0417	5.5166	5.4538
01.07.15	2.9073	247.9900	234.1600	0.0732	-0.7900	0.5100	1.0672	5.5134	5.4560
01.08.15	3.0924	250.4300	234.9600	0.1851	2.4400	0.8000	1.1289	5.5232	5.4594
01.09.15	3.2043	254.2500	236.7800	0.1119	3.8200	1.8200	1.1645	5.5383	5.4671
01.10.15	3.0629	253.7400	241.3400	-0.1414	-0.5100	4.5600	1.1194	5.5363	5.4862
01.11.15	2.9964	250.1300	243.4100	-0.0665	-3.6100	2.0700	1.0974	5.5220	5.4947
01.12.15	3.0447	249.3100	243.5000	0.0483	-0.8200	0.0900	1.1134	5.5187	5.4951
01.01.16	3.0780	250.6700	244.5300	0.0333	1.3600	1.0300	1.1243	5.5241	5.4993
01.02.16	3.0958	250.1600	244.8500	0.0178	-0.5100	0.3200	1.1300	5.5221	5.5006
01.03.16	3.0137	251.1700	245.9500	-0.0821	1.0100	1.1000	1.1032	5.5261	5.5051
01.04.16	2.9994	252.4700	250.0900	-0.0143	1.3000	4.1400	1.0984	5.5313	5.5218
01.05.16	3.1169	256.2100	253.0900	0.1175	3.7400	3.0000	1.1368	5.5460	5.5337
01.06.16	3.0396	257.2700	253.6500	-0.0773	1.0600	0.5600	1.1117	5.5501	5.5360
01.07.16	3.1642	257.8100	254.2100	0.1246	0.5400	0.5600	1.1519	5.5522	5.5382
01.08.16	3.1294	258.0100	254.2500	-0.0348	0.2000	0.0400	1.1408	5.5530	5.5383
01.09.16	3.1878	258.7700	254.6700	0.0584	0.7600	0.4200	1.1593	5.5559	5.5400
01.10.16	3.2461	260.9400	258.2600	0.0583	2.1700	3.5900	1.1775	5.5643	5.5540
01.11.16	3.5389	266.1600	260.1700	0.2928	5.2200	1.9100	1.2638	5.5841	5.5613
01.12.16	3.6195	274.0900	261.2400	0.0806	7.9300	1.0700	1.2863	5.6135	5.5654
01.01.17	3.9228	284.9900	262.9700	0.3033	10.9000	1.7300	1.3668	5.6525	5.5720
01.02.17	3.7472	288.5900	265.0900	-0.1756	3.6000	2.1200	1.3210	5.6650	5.5801
01.03.17	3.7554	291.5800	268.2600	0.0082	2.9900	3.1700	1.3232	5.6753	5.5920
01.04.17	3.7120	293.7900	272.9100	-0.0434	2.2100	4.6500	1.3116	5.6829	5.6091
01.05.17	3.7474	295.3100	276.3400	0.0354	1.5200	3.4300	1.3211	5.6880	5.6216
01.06.17	3.7730	295.5200	276.6600	0.0256	0.2100	0.3200	1.3279	5.6887	5.6228
01.07.17	3.8438	297.6500	278.2700	0.0708	2.1300	1.6100	1.3465	5.6959	5.6286
01.08.17	3.7825	300.1800	279.9900	-0.0613	2.5300	1.7200	1.3304	5.7044	5.6348
01.09.17	3.8890	300.9000	282.4000	0.1065	0.7200	2.4100	1.3582	5.7068	5.6433
01.10.17	4.1042	306.0400	288.7000	0.2152	5.1400	6.3000	1.4120	5.7237	5.6654
01.11.17	4.3005	312.2100	291.8400	0.1963	6.1700	3.1400	1.4587	5.7437	5.6762
01.12.17	4.1700	316.4800	293.3300	-0.1305	4.2700	1.4900	1.4279	5.7573	5.6813

ANNEX B. Greek Alphabet

Simge	Adı			Ses Değeri			Rakam	İbrani	Latin	HTML
	Antik	Orta çağ	Modern	Antik	Orta çağ	Modern				
Α α	alfa (ἄλφα)	alfa (ἄλφα)	alfa (άλφα)	[a] [aː]	[a]	[a]	1	א	a	Α α
Β β	beta (βῆτα)	vita (βῆτα)	vita (βήτα)	[b]		[v]	2	ב	b	Β β
Γ γ	gamma(γάμμα)	gamma(γάμμα)	gama (γάμμα / γάμα)	[g]		[ɣ, ʝ]	3	ג	g	Γ γ
Δ δ	delta (δέλτα)	delta (δέλτα)	delta (δέλτα)	[d]		[ð]	4	ד	d	Δ δ
Ε ε	ei (εἶ)	e psilon (ἒ ψιλόν)	epsilon (έψιλον)	[e]		[e]	5	ה	e	Ε ε
Ζ ζ	zeta (ζήτα)	zita (ζήτα)	zita (ζήτα)	[zd] [dz]		[z]	7	ז	z	Ζ ζ
Η η	eta (ἦτα)	ita (ἦτα)	ita (ήτα)	[ɛː]		[i]	8	ח	ē	Η η
Θ θ	theta (θῆτα)	theta (θῆτα)	tita (θήτα)	[t^{h}]		[θ]	9	ט	th	Θ θ
Ι ι	iota (ἰῶτα)	iota (ἰῶτα)	iota (ἰῶτα)	[i] [iː]		[i]	10	י	i	Ι ι
Κ κ	kappa (κάππα)	kappa (κάππα)	kapa (κάππα)	[k]		[k]	20	כ	k	Κ κ
Λ λ	lambda (λάμβδα)	labda (λάβδα)	lamda (λάμδα / λάμβδα)	[l]		[l]	30	ל	l	Λ λ
Μ μ	mu (μῦ)	mu (μῦ)	mi (μι / μυ)	[m]		[m]	40	מ	m	Μ μ
Ν ν	nu (νῦ)	nu (νῦ)	ni (νι / νυ)	[n]		[n]	50	נ	n	Ν ν
Ξ ξ	ksei (ξεῖ)	ksi (ξῖ)	ksi (ξι)	[ks]		[ks]	60	ס	ks, x	Ξ ξ
Ο ο	ou (οὖ)	o mikron (ὂ μικρο	omikron (όμικρον)	[o]		[o]	70	ע	o	Ο ο
Π π	pei (πεῖ)	pi (πῖ)	pi (πι)	[p]		[p]	80	פ	p	Π π
Ρ ρ	ro (ρω)	ro (ρω)	ro (ῥῶ)	[r]		[r]	100	ר	r, rh	Ρ ρ
Σ σ ς	sigma (σῖγμα)	sigma (σῖγμα)	sigma (σίγμα)	[s] [z]		[s] [z]	200	ש	s	Σ σ ς
Τ τ	tau (ταῦ)	tau (ταῦ)	taf (ταυ)	[t]		[t]	300	ת	t	Τ τ
Υ υ	u (ὖ)	u psilon (ὔ ψιλον)	ipsilon (ύψιλον)	[y] [yː]		[i]	400	ו	u, y	Υ υ
Φ φ	phei (φεῖ)	phi (φῖ)	fi (φῖ)	[p^{h}]	[ɸ]	[f]	500		ph	Φ φ
Χ χ	khei (χεῖ)	khi (χῖ)	khi (χῖ)	[k^{h}]		[x]	600		kh, ch	Χ χ
Ψ ψ	psei (ψεῖ)	psi (ψῖ)	psi (ψι)	[ps]		[ps]	700		ps	Ψ ψ
Ω ω	o (ὦ)	o mega (ώ μέγα)	omega (ωμέγα)	[ɔː]		[o]	800	ע	ō	Ω ω