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ijtimoiy-iqtisodiy, innovatsion texnik,
fan va ta'limga oid ilmiy-amaliy jurnal

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- 05.01.00 – Axborot texnologiyalari, boshqaruv va kompyuter grafikasi
- 05.01.01 – Muhandislik geometriyasi va kompyuter grafikasi. Audio va video texnologiyalari
- 05.01.02 – Tizimli tahlil, boshqaruv va axborotni qayta ishlash
- 05.01.03 – Informatikaning nazariy asoslari
- 05.01.04 – Hisoblash mashinalari, majmualari va kompyuter tarmoqlarining matematik va dasturiy ta'minoti
- 05.01.05 – Axborotlarni himoyalash usullari va tizimlari. Axborot xavfsizligi
- 05.01.06 – Hisoblash texnikasi va boshqaruv tizimlarining elementlari va qurilmalari
- 05.01.07 – Matematik modellash
- 05.01.11 – Raqamli texnologiyalar va sun'iy intellekt
- 05.02.00 – Mashinasozlik va mashinashunoslik
- 05.02.08 – Yer usti majmualari va uchish apparatlari
- 05.03.02 – Metrologiya va metrologiya ta'minoti
- 05.04.01 – Telekommunikatsiya va kompyuter tizimlari, telekommunikatsiya tarmoqlari va qurilmalari. Axborotlarni taqsimlash
- 05.05.03 – Yorug'lik texnikasi. Maxsus yoritish texnologiyasi
- 05.05.05 – Issiqlik texnikasining nazariy asoslari
- 05.05.06 – Qayta tiklanadigan energiya turlari asosidagi energiya qurilmalari
- 05.06.01 – To'qimachilik va yengil sanoat ishlab chiqarishlari materialshunosligi
- 05.08.03 – Temir yo'l transportini ishlatish
- 05.09.01 – Qurilish konstruksiyalari, bino va inshootlar
- 05.09.04 – Suv ta'minoti. Kanalizatsiya. Suv havzalarini muhofazalovchi qurilish tizimlari
- 10.00.06 – Qiyosiy adabiyotshunoslik, chog'ishtirma tilshunoslik va tarjimashunoslik
- 10.00.04 – Yevropa, Amerika va Avstraliya xalqlari tili va adabiyoti
- 08.00.01 – Iqtisodiyot nazariyasi
- 08.00.02 – Makroiqtisodiyot
- 08.00.03 – Sanoat iqtisodiyoti
- 08.00.04 – Qishloq xo'jaligi iqtisodiyoti
- 08.00.05 – Xizmat ko'rsatish tarmoqlari iqtisodiyoti
- 08.00.06 – Ekonometrika va statistika
- 08.00.07 – Moliya, pul muomalasi va kredit
- 08.00.08 – Buxgalteriya hisobi, iqtisodiy tahlil va audit
- 08.00.09 – Jahon iqtisodiyoti
- 08.00.10 – Demografiya. Mehnat iqtisodiyoti
- 08.00.11 – Marketing
- 08.00.12 – Mintaqaviy iqtisodiyot
- 08.00.13 – Menejment
- 08.00.14 – Iqtisodiyotda axborot tizimlari va texnologiyalari
- 08.00.15 – Tadbirkorlik va kichik biznes iqtisodiyoti
- 08.00.16 – Raqamli iqtisodiyot va xalqaro raqamli integratsiya
- 08.00.17 – Turizm va mehmonxona faoliyati

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MUNDARIJA

RASMIY RIVOJLANISH YORDAMI (OFFICIAL DEVELOPMENT ASSISTANCE, ODA) ORQALI O'ZBEKISTONDA DAVLAT MOLIYASINI BOSHQARISH (PUBLIC FINANCIAL MANAGEMENT, PFM) TIZIMINI TAKOMILLASHTIRISH	24
<i>Pulatov Dilshod Haqberdiyevich, Ulug'ova Maftunabonu To'liqinova</i>	
INNOVATIVE TECHNOLOGIES IN LEADING WHEAT-PRODUCING COUNTRIES.....	28
<i>Turayeva Gulizahro</i>	
BLOKCHEYN TIZIMLARI UCHUN XESH FUNKSIYALARNI TANLASH MEZONLARI VA SAMARADORLIK KO'RSATKICHLARI TAHLILI	32
<i>Abduraximov Baxtiyor, Allanov Orif, Turdibekov Baxtiyor</i>	
RIVOJLANGAN DAVLATLAR TAJRIBASI ASOSIDA KICHIK KORXONALARDA ISHLAB CHIQARISHNI SAMARALI TASHKIL ETISH MODELLARI: NAMANGAN VILOYATI MISOLIDA	39
<i>Xonto'rayev Obbosxon Kamolxon o'g'li</i>	
ISSIQLIK AKKUMULYATORINING RAZRYADLANISH JARAYONIDA SUYUQLIK QATLAMLARIDA HARORAT TAQSIMLANISHINING BIR O'LCHOVLI MODEL	43
<i>B.A. Hikmatov, M.S. Mirzayev</i>	
ISLOM MOLIYASI TAMOIYILLARI ASOSIDA YASHIL LOYIHALARNI MOLIYALASHTIRISH IMKONIYATLARI.....	49
<i>Safarova Nasiba Gulmurod qizi</i>	
ПРИМЕНЕНИЕ ИНТЕЛЛЕКТУАЛЬНЫХ СИСТЕМ В ОБУЧЕНИИ СПЕЦИАЛИСТОВ ПО ИНФОРМАЦИОННЫМ ТЕХНОЛОГИЯМ.....	54
<i>Даниярова Улбосын Куатбаевна</i>	
YANGI TURDAGI IKKI QATLAMLI TRIKOTAJ TO'QIMALARI KO'RSATKICHLARINI KOMPLEKS BAHOLASH	58
<i>Ergasheva Rashida Abdug'aniyevna</i>	
HALQALI YIGIRISH MASHINASIDA BURAM UCHBURCHAGINING IP UZILISHIGA BOG'LIQLIGINI TADQIQI.....	62
<i>Soliyev Azizbek Kamoldinovich</i>	
НОВЫЕ ТЕНДЕНЦИИ ТУРИЗМА 2030: СТРАТЕГИЧЕСКИЕ ОРИЕНТИРЫ И РЕКОМЕНДАЦИИ ДЛЯ УЗБЕКИСТАНА	69
<i>Голышева Елена Вячеславовна</i>	
STRATEGIK JARAYONNING MODELLARI	76
<i>Musayeva Dilnoza Dilshatovna</i>	
МАТЕМАТИЧЕСКИЕ МОДЕЛИ ОЦЕНКИ СТОИМОСТИ КВАРТИР В МНОГОЭТАЖНЫХ ДОМАХ.....	81
<i>Уринов Адхамжон Акбарович</i>	
MATERIALLARNI MURAKKAB YASSI TRAEKTORIYALAR BO'YICHA DEFORMASIYALANTIRISHDA PLASTIK DEFORMASIYALANISH JARAYONLARI	88
<i>A.Xakimov, X.Xakimov</i>	
TIJORAT BANKLARI TOMONIDAN LOYIHALARNI ISLOM MOLIYA INSTRUMENTLARI ORQALI MOLIYALASHTIRISH YO'LLARI.....	95
<i>Xaitov Shaxzod Sharipboyevich</i>	
SANOAT KORXONALARINING RAQOBATBARDOSHLIGINI OSHIRISH CHORA-TADBIRLARINING KETMA KETLIGI	102
<i>Xusanova Maloxat Mengnorovna</i>	
TO'QIMACHILIK KORXONALARIDA LOGISTIKA XARAJATLARI TAHLILI	107
<i>Saidova Kamola Xoshimovna</i>	



OZIQ-OVQAT SANOATINI IQTISODIY RIVOJLANTIRISHDA EKOLOGIK MUAMMOLAR VA ULARNI YECHISHNING METODOLOGIK YONDASHUVLARI	111
Tleuv Niyetulla Raxmanovich	
YUQORI MUSTAHKAM KOMPOZIT ARMATURALARDAN FOYDALANILGAN TEMIRBETON KONSTRUKSIYALARINING YUK KO'TARUVCHANLIGI VA UZOQ MUDDATLI DEFORMATSIYALARINI BAHOLASH	114
Mamajanova Odina Alisher qizi	
KORXONALARDA DAROMADLILIK KO'RSATKICHLARINI BAHOLASHNING ZAMONAVIY YONDASHUVLARI	119
Farog'at Xo'jabekova, Eshankulova Nafisa Komiljon qizi	
TEMIR YO'L INFRATUZILMASIDA YASHIL IQTISODIYOT TAMOYILLARINI QO'LLASH: CSR, ESG VA PRI ASOSIDA BARQAROR RIVOJLANISH STRATEGIYASINI SHAKLLANTIRISH	124
Abduraxmanova Muqaddas Toxtasinovna	
THE ROLE OF ARTIFICIAL INTELLIGENCE IN OPTIMIZING MARKETING AND EDUCATIONAL PROCESSES IN HIGHER EDUCATION	128
Sadikov Shoxrux Shuhratovich	
BANK FAOLIYATIDA "YASHIL" MOLIYAVIY VOSITALARDAN FOYDALANISHNING NAZARIY ASOSLARI.....	133
Abduraxmonov Alimardon Sodiq o'g'li	
TIJORAT BANKLARI TOMONIDAN LOYIHALARNI ISLOM MOLIYA INSTRUMENTLARI ORQALI MOLIYALASHTIRISH YO'LLARI	139
Xaitov Shaxzod Sharipboyevich	
BOSHQARUV PSIXOLOGIYASIGA DOIR MUAMMOLARNI BARTARAF ETISHNING ZAMONAVIY YO'NALISHLARI	145
Aripov Oybek Abdullayevich	
TADBIRKORLIK SUBYEKTLARIDA INNOVATSIYALARNI JORIY ETISHNING IQTISODIY SAMARALARI	150
Karimov Nodirbek	
УТИЛИЗАЦИЯ ПОБОЧНЫХ ПРОДУКТОВ ПЕРЕРАБОТКИ ХЛОПКА ДЛЯ СИНТЕЗА АНТИКОРРОЗИОННЫХ КОМПОЗИЦИОННЫХ ПОКРЫТИЙ.....	155
Ситмуратов Тулкинбек Сабирбаевич, Баходиров Худайберган Баходир угли	
SANOAT KORXONALARIDA MOLIYAVIY BARQARORLIKNI TA'MINLASHNING METODOLOGIK ASOSLARI.....	163
Ergashev Muhibbek Aslam o'g'li	
O'ZBEKISTON TO'QIMACHILIK SANOATIDA XORIJIY INVESTITSİYALAR SAMARADORLIGINI OSHIRISH YO'NALISHLARI	168
Nazarova A.N.	
АВТОМАТИЗИРОВАННАЯ СИСТЕМА РАСЧЁТА ПОКАЗАТЕЛЕЙ ЭФФЕКТИВНОСТИ СОТРУДНИКОВ ОРГАНИЗАЦИИ	172
Шухратов Мамуржон Шухрат угли	
BLOCKCHIAN, IOT (INTERNET OF THINGS) NING IQTISODIY SOHALARDA QO'LLANISHI	178
Avazov Ergash Xidirberdiyevich	
O'ZBEKISTONDA INVESTITSİYALARNI MOLIYAVIY BOSHQARISHNING JORIY HOLATI VA EKONOMETRIK TAHLILLAR ASOSIDA KELGUSI YILLAR PROGNOZI.....	182
Ismailov Dilshod Anvarjonovich	
QISHLOQ XO'JALIGI KLASTERLARI MOLIYAVIY HOLATINING NAZARIY JIHATLARI	190
Dildora Yuldasheva	
TURIZM SOHASIDA TRANSPORT XIZMATLARINING HOLATI	194
Xalimov Shaxboz Xalimovich	
MAHALLA BUDJETI VA SOLIQLARNING YIG'ILUVCHANLIGINI OSHIRISH YO'LLARI	200
Abdullayev Zafarbek Safibullayevich	



BUDJET TASHKILOTLARIDA QURILISH-TA'MIRLASH XARAJATLARI HISOBINING USLUBIY JIHATLARI.....	206
Azizova Zilola Lochinovna	
KOSHI – BUNYAKOVSKIY – SHVARS INTEGRAL TENGSIZLIGI VA UNING IQTISODIYOTDAGI ROLI.....	212
Saipnazarov Shaylovbek Aktamovich	
ИНТЕГРАЦИЯ ПРИНЦИПОВ ЦИРКУЛЯРНОЙ ЭКОНОМИКИ В АГРОПРОДОВОЛЬСТВЕННЫЙ СЕКТОР УЗБЕКИСТАНА: ЭКОНОМИЧЕСКАЯ ЭФФЕКТИВНОСТЬ, ПЕРЕРАБОТКА БИОМАССЫ И СТРАТЕГИИ СОКРАЩЕНИЯ ПОСТУБОРОЧНЫХ ПОТЕРЬ	219
Эгамбердиев Хумоюн Хамрокулович	
HOVUZ BALIQCHILIGI XO'JALIKLARIDA REJALASHTIRISHNING MUDDATLARI VA BOSQICHLARI	227
Dosmuratova Shaxista Kengashovna, Menglikulov Bakhtiyor Yusupovich	
O'ZBEKISTON SHAROITIDA KICHIK BIZNESNI QO'LLAB-QUVVATLASH TIZIMINI TAKOMILLASHTIRISH YO'LLARI	233
Ergashev Jamshid Jamoliddinovich	
KON-METALLURGIYA KORXONALARINING KORPORATIV BOSHQARUV TIZIMIDA KPINING O'RNI VA AHAMIYATI.....	237
Ergashov Botirjon Ergashovich	
SANOAT KORXONALARIDA INNOVATSION TEXNOLOGIYALARNI JORIY ETISHNING IQTISODIY SAMARADORLIGI.....	245
Ahmadjanov Ilyosbek	
ACCELERATING SOCIOECONOMIC DEVELOPMENT IN RURAL AREAS THROUGH DIGITAL TECHNOLOGIES: A COMPREHENSIVE ANALYSIS	250
O.Q. Xudayberdiyeva, Z.B. Negmatullayeva	
ISSIQXONALARDAN FOYDALANISHNING OZIY-OVQAT XAVFSIZLIGIGA TA'SIRI BO'YICHA MUAMMONI ASOSLASH VA UNING MILLIY MANFAATLARGA ALOQADORLIGINI ANIQLASH.....	256
Otavullaev Sukhrob Sa'dullo o'g'li	
NAMANGAN VILOYATIDA DON MAHSULOTLARI NARXLARINI SHAKLLANTIRISHDA BOZOR TAJRIBASI	260
Bahriddinov Jahongirbek Ravshanjon o'g'li	
RAQAMLI IQTISODIYOTGA O'TISHNING JAHON TAJRIBASI: MUAMMO VA ISTIQBOL	264
Mamadaliyev Akmaljon	
ПОВЫШЕНИЕ СОЦИАЛЬНОЙ ЗНАЧИМОСТИ НАЛОГОВ В НОВОЙ ЭКОНОМИЧЕСКОЙ СИТУАЦИИ.....	269
Зайналов Джахонгир Расулович	
FARG'ONA VODIYSIDA KICHIK BIZNES VA TADBIRKORLIK SUBYEKTLARI FAOLIYATINI RIVOJLANTIRISHNING HUDUDiy XUSUSIYATLARI	274
Murodxiyeva Feruza Majidovna	
TOG' VA TOG'OLDI HUDUDLARIDA IQLIM O'ZGARISHI SHAROITIDA QISHLOQ XO'JALIGI BARQARORLIGINI TA'MINLASH STRATEGIYALARI.....	280
Abduliyeva Gulshan Maxmudovna	
LABOR MIGRATION IN UZBEKISTAN: SOCIO-ECONOMIC TRENDS AND DEVELOPMENT PROSPECTS	285
Razakova Barno Sayfiyeva	
U-NET BASED POLYP SEGMENTATION ON KVASIR-SEG DATASET: PERFORMANCE EVALUATION AND COMPARISON WITH STATE-OF-THE-ART METHODS	289
Mukhriddin Arabboev, Shohruh Begmatov, Sukhrob Bobojanov	



IQTISODIYOT TARMOQLARI VA SOHALARI RIVOJLANISHIDA SUN'IIY INTELLEKTDAN FOYDALANISH MASALALARI	300
Davletov Islambek Xalikovich, Normirzayev Ulmasjon Muzaffarjon o'g'li	
IQTISODIYOTDA SAMARALI RAQOBAT MUHITINI SHAKLLANTIRISH SHART-SHAROITLARI VA OMILLARI	304
Karimova Iroda Abdusattarovna	
"MENING MAKTABIM" LOYIHASINI OMMALASHTIRISH BO'YICHA XORIJIY MAMLAKATLAR TAJRIBASI	311
Dilshod Pulatov, Xamidaxon Akbarova, Dildora Mirzayeva	
ISSUES OF SUSTAINABLE DEVELOPMENT IN THE EDUCATION MARKET	320
Inomiddin Imomov	
СОВЕРШЕНСТВОВАНИЕ МЕТОДА ОЦЕНКИ ИННОВАЦИОННОЙ ДЕЯТЕЛЬНОСТИ С УЧЕТОМ СТЕПЕНИ НОВИЗНЫ И ЭФФЕКТОВ	324
Алиева Эльнара Аметовна	
ИНТЕГРАЦИЯ ЦИФРОВЫХ БИЗНЕС-МОДЕЛЕЙ В СИСТЕМУ КОНКУРЕНТНЫХ ПРЕИМУЩЕСТВ ПРЕДПРИЯТИЙ В УЗБЕКИСТАНЕ	331
Назарова Гулчехра Нурмуханбетовна	
ECONOMIC GROWTH: THEORETICAL AND PRACTICAL ASPECT	336
Bustonov Mansurjon Mardonakulovich	
AGROKLASTERDAGI XO'JALIK YURITUVCHI SUBYEKTLAR O'RTASIDAGI O'ZARO ALOQALAR MEKANIZMINING BUGUNGI HOLATI	342
Xaydarov Sardor Komil o'g'li	
SIMSIZ ALOQA TEXNOLOGIYALARI YORDAMIDA TEMIR YO'L STANSIYALARIDA POYEZDLAR HARAKATINI TASHKIL ETISH	350
Jonikulov Egamberdi Shavkat o'g'li	
GENDER SIYOSATI VA DEMOGRAFIK O'SISHNING INSON KAPITALIGA TA'SIRI	357
Ruzmetova Gulira'no Atabekovna	
СОСТОЯНИЕ ВИТАМИННО-МИНЕРАЛЬНОГО ОБМЕНА (ВИТАМИН D, КАЛЬЦИЙ, МАГНИЙ, ФОСФОР) У ДЕТЕЙ РАННЕГО ВОЗРАСТА С ОСТРОЙ ПНЕВМОНИЕЙ НА ФОНЕ ВЕГЕТАТИВНЫХ ДИСФУНКЦИЙ	364
Абдурахмонов Жасур Нематович, Шарипова Олия Аскаровна, Бахронов Шерзод Самиевич	
YASHIL IQTISODIYOTNING MOHIYATI VA TARKIBIY TUZILISHI	373
Kalandarova Elnura Muzaffar qizi	
ОСНОВНЫЕ НАПРАВЛЕНИЯ ОЦЕНКИ ФИНАНСОВОЙ УСТОЙЧИВОСТИ АО ХУДУДГАЗТАЪМИНОТ	377
Хусанов Дурбек Нишанович	
ТЕМИР YO'L TRANSPORTIDA NAZORAT GABARIT QURILMALARINING ZAMONAVIY HOLATI, TAHLILI VA HARAKAT TAKRIBI GABARITLARINI ANIQLASH USULINI TAKOMILLASHTIRISH	384
Xidirov Erkin Irgashovich	
QISHLOQ XO'JALIGIDA SUV RESURSLARIDAN FOYDALANISH VA SAMARALI TAQSIMLASHDA RIVOJLANGAN XORIJIY MAMLAKATLAR TAJRIBALARI	391
Amanbaev Amanali Ortazbaevich	
GLOBAL DARAJADA FAOLIYAT YURITADIGAN BRONLASH TIZIMLARINING ILG'OR XORIY TAJRIBALARI	396
Ismatillaeva Sitara Sayfidin qizi	
DAVLAT-XUSUSIY SHERIKLIGI ASOSIDA INFRATUZILMA LOYIHALARNI MOLIYALASHTIRISHNING NORMATIV-HUQUQIY ASOSLARI	403
Akmal Shodiyev	
QISHLOQ XO'JALIGI MAHSULOTLARI ISHLAB CHIQUVCHI KORXONALARDA LIZING MUNOSABATLARI HISOBİ	408
Inamov Abdusalom Muhamadovich, Inomov Sardor Abdusalomovich, Inomov Hasanboy Abdusalom o'g'li	



O'TKIR BRONXOLIT BILAN KASALLANGAN BOLALARDA KATAMNEZNING EKOLOGIK OMILLAR TA'SIRIDA UZIGA XOS KECHISHI.....	412
Azimova Kamola Talatovna	
THEORETICAL ASPECTS OF STUDYING CONCEPTS RELATED TO YOUTH TOURISM	416
Norboyev Allayor Ismoilovich, Mansurova Zebuniso Abdurashidovna	
THE ESSENTIAL STRATEGIES WAYS OF SERICULTURE INDUSTRY OF THE REPUBLIC OF UZBEKISTAN.....	420
Khojimatov Ravshanbek Rasuljonovich	
BLENDED LEARNING PLATFORMASI KANSEPSIYASI, ARXITEKTURASI VA FUNKSIONAL TUZILMASI.....	425
Qobulova Madina Tuxbatillo qizi, Mirzaaxmedov Muxammadbobur Karimberdiyevich	
ASALARICHILIKNI RIVOJLANTIRISHNING AHOLI DAROMADLARI VA FAROVONLIGIGA TA'SIRI: IQTISODIY TAHLIL VA EKONOMETRIK BAHOLASH	430
Kuanishbay Berdimuratov	
MARKETING EKOTIZIMINI SHAKLLANTIRISHGA OID XORIJIY YONDASHUVLAR TAHLILI	434
Sobirov Azizbek Avazbekovich	
УЧЕТНО-АНАЛИТИЧЕСКОЕ ОБЕСПЕЧЕНИЕ УПРАВЛЕНИЯ ДЕНЕЖНЫМИ ПОТОКАМИ ОРГАНИЗАЦИИ	443
Бабахонов Бабуржон Шухрат угли	
KICHIK BIZNES SUBYEKTLARIGA SOLIQ IMTIYOZLARINI QO'LLASH MASALALARI.....	449
Ibroximov Muxammadjon Abdullajanovich	
QISHLOQ XO'JALIGIDA LOGISTIKA BOSHQARUVINING RAQAMLI MODEL VA UNING SAMARADORLIGI	453
Olimova Bahora Shuxratovna	
СУЩНОСТЬ И ЭКОНОМИЧЕСКОЕ СОДЕРЖАНИЕ ФИНАНСОВЫХ РЕЗУЛЬТАТОВ ПРЕДПРИЯТИЯ.....	463
Муминходжаева Дилноза Рамизовна	
ИННОВАЦИОННЫЕ МЕТОДЫ УПРАВЛЕНИЯ ФИНАНСОВЫМИ РИСКАМИ В СЕЛЬСКОМ ХОЗЯЙСТВЕ НА ОСНОВЕ ЦИФРОВЫХ ТЕХНОЛОГИЙ И АНАЛИТИЧЕСКИХ ПЛАТФОРМ	468
Дурманов Акмал Шаймарданович	
УПРАВЛЕНИЕ ИННОВАЦИОННЫМ РАЗВИТИЕМ СОЦИАЛЬНОГО СЕКТОРА ЭКОНОМИКИ: ВЫЗОВЫ И НАПРАВЛЕНИЯ РЕФОРМ В СФЕРЕ ОБРАЗОВАНИЯ И ЗДРАВООХРАНЕНИЯ УЗБЕКИСТАНА.....	477
Холмуратов Джахонгир Салимбек угли	
O'ZBEKISTONDA XORIJIY INVESTITSİYALARNI JALB ETISHDA TIJORAT BANKLARINING ROLI.....	483
Yuldashev Erkin Xusanovich	
MINTAQAVIY INVESTITSIYA-INNOVASION JARAYONLARGA TA'SIR ETUVCHI OMILLAR	489
Xamrayev Quvvat Iskandarovich	
AGROKLAsterlarda ICHKI SOTISH JARAYONIDA TRANSFERT BAHOLARNI BELGILASH USULLARINI TAKOMILLASHTIRISH	495
Eshmuradov Ulug'bek Tashmuratovich	
INTERNATIONAL EXPERIENCE IN THE DEVELOPMENT OF MICE TOURISM AND ITS ADAPTATION TO THE CONDITIONS OF THE REPUBLIC OF UZBEKISTAN.....	501
Ilkhomova Gulnoza Zayniddin kizi	
MUHANDISLIK KONSTRUKSIYALARIDA MURAKKAB SIRTlARNI CHIZMA GEOMETRIYA YORDAMIDA TAHLIL QILISH.....	507
Qutbtiddinov Hikmatillo Qudratillo o'g'li	
TADBIRKORLIKNI QO'LLAB-QUVVATLASHNING ZAMONAVIY MEXANIZMLARI VA ULARNING IQTISODIY RIVOJLANISHGA TA'SIRI	512
Umarova Munira Muxitdinovna	



JINDA ARRALI SILINDR TISHLARIDAN TOLANI AJRATISH JARAYONINI HAVO OQIMI ASOSIDA OPTIMALLASHTIRUVCHI ENERGIYA TEJAMKOR QURILMANI MODELLASHTIRISH.....	516
Mirzakarimov Mirsharofiddin Mirzaabdurahimovich	
TADBIRKORLIK SUBYEKTLARI TOMONIDAN ISHLAB CHIQUARILGAN MAHSULOTLARNI XORIJGA EKSPORT QILISH MEKANIZMLARI	524
Matkarimov Anvar Tajimatovich	
MUHANDISLIK KONSTRUKSIYALARIDA MURAKKAB SIRTLARNI CHIZMA GEOMETRIYA YORDAMIDA TAHLIL QILISH	528
Qutbtiddinov Hikmatillo Qudratillo o'g'li	
SOLIQ TO'LOVCHILAR FAOLIYATINI SOLIQ NAZORATINI AMALGA OSHIRISHNING NAZARIY ASOSLARI	533
Ismailov Bobir Salomovich	
QISHLOQ XO'JALIK KORXONALARIDA KAPITAL QO'YILMALAR XUSUSIYATLARI VA ULAR AUDITINI TAKOMILLASHTIRISH	540
Baxriyev Muxiddin Sheraliyevich	
QISHLOQ XO'JALIK KORXONALARIDA ASOSIY VOSITALAR VA ULAR BUXGALTERIYA HISOBINING XUSUSIYATLARI.....	545
Fayzullayev Murodjon Nematulayevich	
O'ZBEKISTONDA KLASSTER IQTISODIYOTI: INVESTITSİYALAR, EKSPORT VA SANOAT ISHLAB CHIQUARISHNING ZAMONAVIY TENDENSIYALARI (2022-2024-YILLAR KESIMIDA).....	550
O'rinboyev Ulug'bek Otabekovich, Jabbarov Majidbek Erzodovich, Ruzmetova Gulira'no Atabekovna	
GLOBAL YASHIL IQTISODIYOT SHAROITIDA XIZMAT KO'RSATISH SOHASINI SAMARADORLIGINI BAHOLASHDA EKOLOGIK, IJTIMOY-IQTISODIY OMILLARNING TAHLILI	556
M.M.Muminova	
RAQAMLI TRANSFORMATSIYA VA SMART TURIZM SHAROITIDA TURIZM INFRATUZILMASINI RIVOJLANTIRISHNING XORIJIY TAJRIBASI VA O'ZBEKISTON ISTIQBOLLARI	565
Najmidinov Azizbek Bahrom o'g'li	
ТЕКУЩИЕ УГРОЗЫ И ВЫЗОВЫ, СВЯЗАННЫЕ С МИГРАЦИОННЫМИ КРИЗИСАМИ	571
Бегматов Хусанбек	
ELEKTRON TIJORAT SEKTORI UCHUN ONLAYN REKLAMA SAMARADORLIGINI BAHOLASH	575
Rajabova Dilbar Ixtiyor qizi	
RAQAMLI TRANSFORMATSIYA SHAROITIDA O'ZBEKISTON MEVA-SABZAVOTCHILIK SOHASIDA MAHSULOT YETISHTIRISHDAN TORTIB UNI BOZORGA CHIQUARISHGACHA BO'LGAN JARAYONDA NEYROMARKETING TEXNOLOGIYALARINI QO'LLASHNING NAZARIY VA AMALIY JIHATLARI	582
Sadiy Shukrillo Asatillo o'g'li	
YOSH TADBIRKORLAR FAOLIYATIDA INNOVATSION G'OYALARNING AMALIY AHAMIYATI	590
Ergashev Oybek Xaydaraliyevich	
ТЕХНОЛОГИЯ НЕТРАДИЦИОННОГО СБАЛАНСИРОВАННОГО КОМБИКОРМА, С ОБОГАЩЕННЫМ БЕЛКОМ И ФЕРМЕНТАМИ СОСТАВОМ ИЗ ГРИБКА PLEUROTUS OSTREATUS.....	594
Ниезов Хусан Ниез угли	
MINTAQAVIY RIVOJLANISH INDIKATOR TIZIMINING AHAMIYATI	601
Turdiyev Ulug'bek Qayumovich	
RAQAMLI IQTISODIYOT SHAROITIDA EKSPORTNI RAG'BATLANTIRISH BO'YICHA DAVLAT SIYOSATI	608
Abdug'aniyev Murodjon Shavkat o'g'li	
TO'QIMACHILIK KORXONALARINING RAQOBATBARDOSHLIGINI BOSHQARISH JARAYONI VA TIZIMI	612
Xonkeldiyeva Komilaxon Ravshanjon qizi	



SPORT SANOATINING INNOVATSION RIVOJLANISHIGA OID XORIJIY TAJRIBALAR TAHLILI.....	616
Xamraqulov Ixtiyor Baxtiyorovich	
MARKAZLASHTIRILGAN DISPETCHERLIK TIZIMIDA POEZDLAR HARAKATI XAVFSIZLIGINI TA'MINLASHDA AVTOMATLAR NAZARIYASIGA ASOSLANGAN INTEGRATSIYALASHGAN MATEMATIK MODEL.....	620
Muhiddinov Obidjon Omonjon o'g'li	
ПРОЦЕНТНЫЙ РИСК ПО КРЕДИТАМ: АНАЛИЗ, ОЦЕНКА И УПРАВЛЕНИЕ.....	627
Абдуллаев Шахобиддин Шамсиддинович	
REDUCTION OF GREENHOUSE GAS EMISSIONS: EMISSION QUOTAS OR MANDATORY CONTROL TECHNOLOGIES	633
Bobonov Doston Abdumo'min o'g'li, Qozoqboyev Jasur Abduvali o'g'li	
AYOLLAR TADBIRKORLIK FAOLIYATINI BAHOLASH METODOLOGIYASINI TAKOMILLASHTIRISH (NAMANGAN VILOYATI MISOLIDA).....	637
Raximova Moxigul Isroiljonovna	
ПОЛУЧЕНИЕ СТОМАТОЛОГИЧЕСКОГО ЦЕМЕНТА С ИСПОЛЬЗОВАНИЕМ ВОЗОБНОВЛЯЕМЫХ ИСТОЧНИКОВ ЭНЕРГИИ.....	643
Арипова Мастура Хикматовна, Ташбаев Джахангир Назим угли	
МОДЕЛИРОВАНИЕ ПРОМЫШЛЕННЫХ ГОРЕЛОК И ИССЛЕДОВАНИЕ ИХ ТЕПЛОВОЙ НАГРУЗКИ	652
Ражабов Азамат Тоирович	
QISHLOQ XO'JALIK TEXNIKALARI MARKETINGI VA UNING SAMARADORLIK KO'RSATKICHLARI.....	658
Xolmirzayev Bobur Mansurovich	
ПРИМЕНЕНИЕ СУБСИДИАРНОЙ ОТВЕТСТВЕННОСТИ НА ДОСУДЕБНОЙ СТАДИИ АНКРОТСТВА: ЗАРУБЕЖНЫЙ ОПЫТ И ВОЗМОЖНОСТИ ВНЕДРЕНИЯ В УЗБЕКИСТАНЕ	663
Хамзина Динара Рашатовна	
YASHIL REKREATIONS TURIZM KONSEPSIYASINI JORIY ETISHNING ILMIY-AMALIY JIHATLARI.....	669
Baxriyeva Zarina Nasimovna	
KORXONALARDA DIVERSIFIKATSIYA SIYOSATINI SHAKLLANTIRISHDA IQTISODIY MEXANIZMLARINING O'RNI	672
Mirzarayimova Feruza Zokirjon qizi, Levakov Izzatulla Nematillayevich	
QALINLIGI 2 MM BO'LGAN TASMALI LISTLARNI SOVUQ HOLATDA PROKATLASH TEXNOLOGIK JARAYONINI ISHLAB CHIQISH	679
Yusupov Abdulaziz Abdullajanovich, Saydumarov Botir Muradovich, Arslonov Asadbek G'aybulla o'g'li	
HUDUDIIY TARMOQLANGAN AVTOMOBIL YO'LLARI MUHANDISLIK INSHOOTLARI KOMPLEKSINI LOYIHALASH VA QURISH JARAYONLARINI MODELLASHTIRISH.....	682
Zikrayev Akmaljon Alimovich	
TIJORAT BANKLARI FAOLIYATIDA DAROMADLARNI OSHIRISH YO'LLARI.....	688
Ostonaqulova Gulchehraxon Muhammadyoqub qizi	
"MIKROSIMULYATSION MODELLAR" VA ULAR YORDAMIDA IQTISODIY SIYOSATGA OID QARORLARNING TADBIRKORLIK SUBYEKTLARIGA TA'SIRINI BAHOLASHDAGI AHAMIYATI.....	694
Mualliflar Pulatov Dilshod Xaqberdiyevich, Raxmonov Doniyor Ixtiyorjon o'g'li, Ortiqova Niginabonu Alisher qizi, Raxmonov Jo'rabek Hamroyevich	
MINTAQADA SANOAT KORXONALARI TUZILMAVIY KO'RSATKICHLAR TIZIMI VA TAMOIYILLARI.....	702
Jabborov Elbek Erkin o'g'li	
MOLIYAVIY REJALASHTIRISH VA TARTIBGA SOLISH	707
Sharoxmatov Abduraxim Abdulamitovich	



SMART SOATLAR YORDAMIDA BEMORLAR SALOMATLIGINI NAZORAT QILISH.....	712
Alimqulov Nurmuhammad Muqumjon o'g'li, Eraliyev Humoyun Ma'mirjon o'g'li, Madaminova Mahliyo Bahodirjon qizi	
PENSIYA JAMG'ARMASI FAOLIYATINI TARTIBGA SOLISHDA DAVLATNING ROLI	718
Sherjonov Doniyor Sapparbayevich	
TOG'-KON SANOATI KORXONALARIDA BARQAROR RIVOJLANISH IMKONIYATLARINI BAHOLASH.....	722
Karimov Ma'ruf Ixtiyorovich	
MINTAQA IQTISODIYOTINI RIVOJLANTIRISHDA ISLOM MOLIYASINING AHAMIYATI	726
Sultonov Baxtiyor Baxodirovich	
UCH FAZALI IKKI CHULG'AMLI MOYLI TRANSFORMATORLARNING ISSIQLIK HISOBINI MODELLASHTIRISH VA TADQIQ QILISH	731
Taniyev Mirzoxid Xurramovich, Bekishev Allabergen Yergashevich, Omonboyev Dilrux Nuraddin o'g'li	
ERKIN IQTISODIY ZONALARNING RIVOJLANISHI BOSQICHLARI	736
Mamadiyev Elyor Akmalovich, Sharipov K. A.	
MOLIYAVIY INKLYUZIYANING IJTIMOIIY TABAQALANISHGA TA'SIRINING NAZARIY JIHATLARI.....	740
Adashaliyev Baxtiyorjon Valisher o'g'li	
ВОПРОСЫ ТРАНСФОРМАЦИИ БУХГАЛТЕРСКОГО УЧЁТА ОСНОВНЫХ СРЕДСТВ К МЕЖДУНАРОДНЫМ СТАНДАРТАМ БУХГАЛТЕРСКОГО УЧЁТА	746
Муҳидинов Аюббек Нуритдинович	
РОЛЬ КОЛЛЕКТОРНО-ДРЕНАЖНЫХ СИСТЕМ В СЕЛЬСКОМ ХОЗЯЙСТВЕ	753
Жангабаев Данияр Мансурович, Хожамуратова Роза Тажимуратовна	
ASSESSMENT OF ESG INDICES OF PRESTIGIOUS HOTELS IN UZBEKISTAN	759
Saidova Madina Xayrullo qizi	
FISKAL SIYOSATDA MAHALLIY BYUDJETLAR MUSTAQILLIGINI OSHIRISHNING MOLIYAVIY INSTRUMENTLARI	765
Muxitdinov Sidikxo'ja Akobirxo'ja o'g'li	
TRANSFORMATSIYALASH JARAYONIDA TIJORAT BANKLARI KREDITLASH AMALIYOTINING XORIIY TAJRIBASI.....	771
Jabbarov Nodir Umirovich	
AKSIZ SOLINISHNING IJTIMOIIY-IQTISODIY TA'SIRI	775
Abdulxayeva Shaxnoza Muxammadiyevna	
O'ZBEKISTONDA QISHLOQ XO'JALIGINING IQTISODIY-STATISTIK TAHLILI VA UNI RIVOJLANTIRISH ISTIQBOLLARI	781
Shavkat Djumaniyazov	
EKISHDA CHIGITNI BIR XIL TARQATISH VA OPTIMALLASHTIRISH USULLARI.....	787
Imomov Shavkat Jaxonovich, Nuritov Ikrom Rajabovich, Babamuradov Anvar Baxtiyorovich	
KICHIK BIZNES VA XUSUSIY TADBIRKORLIKDA KOMPLEKS IQTISODIY TAHLIL TIZIMINI JORIY ETISH	790
Akbarov Akramjon Ibroximjonovich	
INNOVASION FAOLIYAT XARAJATLARINING BUXGALTYERIYA HISOB VA AUDITINI TAKOMILLASHTIRISH.....	793
Mustafoev Akbar Mustafo o'g'li	
INTELLIGENT SYSTEM FOR MONITORING AND MANAGEMENT OF THE VEGETABLE OIL REFINING PROCESS	798
Ortiqov Elbek Elmirza o'g'li	
O'ZBEKISTONDA KREATIV INDUSTRIYA VA EVENT-MENEJMENTNING HUQUQIY-ME'YORIY ASOSLARI.....	806
Shaxabatdin Maxamatdinov Isak uli	



РОЛЬ И РАЗВИТИЕ ТРАНСПОРТНОЙ ИНФРАСТРУКТУРЫ В ТОРГОВЫХ ОТНОШЕНИЯХ МЕЖДУ УЗБЕКИСТАНОМ И КИТАЕМ.....	812
Wang Jianhong, Норов Улугбек Ирискулович	
FARMATSEVTIKA KORXONALARIDA YORDAMCHI ISHLAB CHIQARISH JARAYONLARI HISOB VA YORDAMCHI MAHSULOTLAR TANNARXINI ANIQLASHNING O'ZIGA XOS JIHATLARI	816
Xudaynazarova Dilnoza Gafurovna	
XO'JALIK YURITUVCHI SUBYEKTLARNING ASOSIY IQTISODIY KO'RSATKICHLARINI STRATEGIK BOSHQARUV HISOB DOIRASIDA SHAKLLANTIRISH VA ULARNING HOLATINI TAHLIL QILISH	821
Hamroyeva Zuhra Amiral qizi	
К ВОПРОСУ РАСЧЕТА МОЩНОСТИ, НЕОБХОДИМОЙ ДЛЯ РАЗОГРЕВА КРОМОК ТРУБНОЙ ЗАГОТОВКИ ДО ТЕМПЕРАТУРЫ СВАРКИ	825
Заиркулов Элёр Ёкубжон ўғли	
TEKNOLOGIK JARAYONLARNI BOSHQARISHNING AVTOMATLASHTIRILGAN TIZIMLARI	830
Bekishev Allabergen Yergashevich, Hamadulloyev Diyorbek Hasanboy o'g'li	
ESG (ENVIRONMENTAL, SOCIAL AND GOVERNANCE) TAMOYILLARINING IQTISODIY RIVOJLANISH VA KORPORATIV FAOLIYATGA TA'SIRI: MAKRO VA MIKRO DARAJADAGI TAHLIL	834
Murtozayev Sardorbek Abdijalil o'g'li	
TESTING THE STATISTICAL SIGNIFICANCE OF DYNAMIC MODELS IN ECONOMICS	838
Muradov Rustamjon Sobitkhonovich	



TESTING THE STATISTICAL SIGNIFICANCE OF DYNAMIC MODELS IN ECONOMICS

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Abstract. Dynamic econometric models are widely used to analyze economic processes evolving over time. This paper investigates methods for testing the statistical significance of dynamic models and applies them to regional economic data from the Namangan region of Uzbekistan. Using annual data on gross regional product (GRP), investment in fixed capital, and employment for 2005–2023, we estimate an autoregressive distributed lag (ARDL) model and conduct individual and joint significance tests. The results confirm statistically significant dynamic relationships and highlight the importance of lag effects in regional growth analysis.

Keywords: dynamic models, statistical significance, autoregressive distributed lag, regional growth, time series analysis.

Annotatsiya. Dinamik ekonometrik modellar vaqt davomida rivojlanib boruvchi iqtisodiy jarayonlarni tahlil qilishda keng qo'llaniladi. Ushbu maqolada dinamik modellar uchun statistik ahamiyatlilikni tekshirish usullari o'rganiladi va ular O'zbekistonning Namangan viloyati bo'yicha mintaqaviy iqtisodiy ma'lumotlarga tatbiq etiladi. 2005–2023 yillar davomida yalpi hududiy mahsulot (YHM), asosiy kapitalga investitsiyalar va bandlik bo'yicha yillik ma'lumotlardan foydalanib, avtoregressiv taqsimlangan kechikishli (ARDL) model baholanadi hamda alohida va qo'shma ahamiyatlilik testlari o'tkaziladi. Natijalar dinamik bog'liqliklarning statistik jihatdan ahamiyatli ekanini tasdiqlaydi va mintaqaviy iqtisodiy o'sishni tahlil qilishda kechikish ta'sirlarining muhimligini ko'rsatadi.

Kalit so'zlar: dinamik modellar, statistik ahamiyatlilik, avtoregressiv taqsimlangan kechikish (ARDL), mintaqaviy o'sish, vaqtli qatorlar tahlili.

Аннотация. Динамические эконометрические модели широко используются для анализа экономических процессов, развивающихся во времени. В данной статье исследуются методы проверки статистической значимости динамических моделей и применяется их апробация на региональных экономических данных по Наманганской области Узбекистана. На основе годовых данных по валовому региональному продукту (ВРП), инвестициям в основной капитал и занятости за 2005–2023 годы оценивается модель авторегрессии с распределёнными лагами (ARDL) и проводятся индивидуальные и совместные тесты значимости. Полученные результаты подтверждают статистически значимые динамические взаимосвязи и подчёркивают важность лаговых эффектов при анализе регионального экономического роста.

Ключевые слова: динамические модели, статистическая значимость, авторегрессионная модель с распределёнными лагами (ARDL), региональный рост, анализ временных рядов.

INTRODUCTION

Economic phenomena such as output growth, inflation, investment, and unemployment exhibit strong dynamic behavior, where current outcomes depend on past values and expectations. Dynamic econometric models are therefore widely used in macroeconomics, finance, and applied economic research. However, the usefulness of these models depends critically on whether the estimated parameters are statistically significant and economically meaningful.

Testing statistical significance serves two main purposes: (i) to verify whether explanatory variables genuinely influence the dependent variable over time, and (ii) to assess the adequacy of model specification. In dynamic models, standard inference is complicated by serial correlation, lag structures, non-stationarity, and potential endogeneity.



This paper aims to systematize approaches for testing statistical significance in dynamic economic models. The objectives are to review common dynamic model structures, to present hypothesis testing procedures for individual and joint significance, and to demonstrate their application with an empirical example.

Dynamic models are particularly useful for regional economies like Namangan, where investment activity and labor dynamics affect growth with time lags. This study contributes by providing empirical evidence from Uzbekistan's regional data.

REVIEW OF LITERATURE ON THE SUBJECT

The analysis of dynamic relationships in economics has a long tradition in econometrics, with early foundations laid by autoregressive and distributed lag models. Box and Jenkins (1976) formalized the ARIMA methodology, providing a systematic approach to modeling and forecasting time series processes with dynamic dependence. Their work established the importance of identifying lag structures and testing parameter significance to ensure reliable inference.

Hamilton (1994) further advanced the theory and application of time-series econometrics, emphasizing likelihood-based inference and hypothesis testing in autoregressive models. He highlighted that statistical significance in dynamic settings must account for serial correlation and potential non-stationarity, as ignoring these features can lead to spurious regression results.

The problem of non-stationarity and long-run relationships was addressed by Engle and Granger (1987), who introduced the concept of cointegration and error correction models (ECM). Their framework allows researchers to distinguish between short-run dynamics and long-run equilibrium, and to test the statistical significance of both adjustment speeds and long-run coefficients. Johansen (1995) later extended this approach using a multivariate maximum likelihood method for testing cointegration in VAR systems.

Sims (1980) proposed vector autoregression (VAR) models as a flexible tool for analyzing dynamic interdependencies among macroeconomic variables without imposing strong a priori restrictions. Subsequent studies (Lütkepohl, 2005) demonstrated the role of Wald, likelihood ratio, and Granger causality tests in assessing the joint statistical significance of lagged variables within VAR frameworks.

Pesaran, Shin, and Smith (2001) introduced the ARDL bounds testing approach, which allows for inference on both short-run and long-run dynamics irrespective of whether regressors are integrated of order zero or one. Their method has become particularly popular in applied economic research, as it facilitates testing the joint significance of lagged level variables to establish long-run relationships.

In the context of hypothesis testing, Greene (2018) and Wooldridge (2010) provide comprehensive treatments of t-tests, F-tests, and Wald tests in dynamic regression models, emphasizing the need for robust standard errors when classical assumptions are violated. Newey and West (1987) developed heteroskedasticity and autocorrelation consistent (HAC) covariance estimators, which are now widely used to improve the reliability of significance testing in time-series models.

More recent empirical studies apply dynamic models to growth, finance, and regional economics. For example, Asteriou and Hall (2015) and Enders (2015) show that the statistical significance of lagged macroeconomic variables is crucial for understanding persistence and transmission mechanisms in economic systems. In regional growth studies, dynamic panel models and ARDL specifications have been employed to assess the impact of investment and labor on output, often finding significant short-run and long-run effects (Baltagi, 2021).

Despite this rich literature, several authors note that applied studies sometimes focus on coefficient estimates while paying insufficient attention to diagnostic checking and joint significance testing (Lütkepohl, 2005; Wooldridge, 2010). This gap motivates the present study, which integrates rigorous statistical testing with an applied dynamic model for a regional economy, thereby contributing to both methodological clarity and empirical relevance.

RESEARCH METHODOLOGY

A general dynamic regression model can be written as:

$$y_t = \alpha + \sum_{i=1}^p \phi_i y_{t-i} + \sum_{j=0}^q \beta_j x_{t-j} + \varepsilon_t,$$

where y_t is the dependent variable, x_t is an explanatory variable, p and q are lag orders, and ε_t is a white-noise error term.

Special cases include

- AR(p): $y_t = \alpha + \sum_{i=1}^p \phi_i y_{t-i} + \varepsilon_t$,
- ARDL(p,q): includes lags of both y_t and x_t ,
- VAR(k):

$$y_t = c + \sum_{i=1}^k A_i y_{t-i} + u_t,$$

where y_t is a vector of endogenous variables,

- ECM: derived when variables are cointegrated.

Statistical significance is assessed through hypotheses of the form

$$H_0: \theta = 0 \text{ vs. } H_1: \theta \neq 0,$$

where θ is a model parameter.

Key tests include:

- (a) t-test (individual significance)

$$t = \frac{\hat{\theta}}{SE(\hat{\theta})},$$

used to test whether a single coefficient differs from zero.

- (b) F-test / Wald test (joint significance):

$$F = \frac{(RSS_r - RSS_u)/m}{RSS_u/(T - k)},$$

where RSS_r and RSS_u are restricted and unrestricted residual sums of squares, m is the number of restrictions.

- (c) Likelihood Ratio (LR) test:

$$LR = -2(\ln L_r - \ln L_u),$$

asymptotically $\chi^2(m)$.

- (d) Overall model significance: based on the joint null that all slope coefficients equal zero.

We consider an ARDL (1,1,1) model

$$g_t = \alpha + \phi g_{t-1} + \beta_0 inv_t + \beta_1 inv_{t-1} + \gamma_0 emp_t + \gamma_1 emp_{t-1} + \varepsilon_t,$$

where g_t — GRP growth rate in Namangan (%), inv_t — growth of investment in fixed capital (%), emp_t — employment growth (%).

Results and Analysis

Annual data for 2005–2023 (19 observations) were compiled from the State Statistics Committee of Uzbekistan. Variables were transformed into growth rates to ensure stationarity (Table 1).

Table 1. Descriptive Statistics of Key Macroeconomic Growth Variables Used in the Dynamic Econometric Model

Variable	Mean	Std. Dev.	Min	Max
GRP growth (%)	6.1	1.9	2.8	9.5
Investment growth (%)	11.4	4.7	3.5	21.6
Employment growth (%)	2.3	0.8	0.9	4.1

ADF tests reject the unit root at 5% for all growth rates.

Estimated ARDL (1,1,1) model:

$$\hat{g}_t = 1.25 + 0.52g_{t-1} + 0.18inv_t + 0.10inv_{t-1} + 0.95emp_t + 0.40emp_{t-1}.$$



Table 2. Estimation Results of the Dynamic Regression Model and Statistical Significance of Coefficients

Variable	Coefficient	Std. Error	t-stat	p-value
Constant	1.25	0.48	2.60	0.02
g_{t-1}	0.52	0.14	3.71	0.003
inv_t	0.18	0.07	2.57	0.02
inv_{t-1}	0.10	0.05	2.00	0.06
emp_t	0.95	0.32	2.97	0.01
emp_{t-1}	0.40	0.18	2.22	0.04

Model fit:

$$R^2 = 0.78, F = 9.6 \ (p < 0.001).$$

At 5% significance level:

- Lagged growth g_{t-1} is highly significant $\rightarrow$ strong persistence.
- Current investment and employment are significant drivers of GRP growth.
- Lagged investment is marginally significant (10% level).
- Lagged employment remains significant at 5%.

Thus, both short-run and delayed effects matter.

Joint Significance (F-test):

$$H_0: \beta_0 = \beta_1 = 0 \text{ (investment has no effect)} \quad \text{Computed:}$$

$$F = 5.4 > F_{0.05}(2,12) = 3.89, \Rightarrow \text{reject } H_0. \text{ Investment variables are jointly significant.}$$

Similarly, employment lags are jointly significant with $F = 6.1$ (Table 3).

Table 3. Diagnostic Test Results for the Dynamic Econometric Model

Test	Statistic	p-value	Conclusion
Breusch–Godfrey (AR(1))	1.12	0.31	No serial correlation
White test	1.45	0.24	Homoskedastic
Jarque–Bera	0.98	0.61	Normal residuals
CUSUM	—	—	Stable parameters

Hence, standard inference is valid.

Economic interpretation:

- A 1% increase in current investment growth raises GRP growth by 0.18% in the same year.
- A 1% rise in employment growth increases GRP growth by 0.95%, showing strong labor intensity.

• The coefficient 0.52 on g_{t-1} indicates significant inertia: about half of last year's growth carries into the current year.

This confirms the dynamic nature of Namangan's regional economy.

The empirical results for the Namangan region confirm the relevance of dynamic econometric modeling for regional economic analysis. The statistically significant coefficient on the lagged dependent variable indicates strong persistence in GRP growth, suggesting that past economic performance plays a crucial role in shaping current outcomes. This finding is consistent with endogenous growth theory and highlights the inertia typical of regional economies with relatively stable industrial and agricultural structures.

The individual t-tests reveal that both investment growth and employment growth exert a positive and statistically significant impact on regional output in the short run. In particular, the strong effect of employment growth reflects the labor-intensive nature of Namangan's economy, where manufacturing, agriculture, and small-scale enterprises dominate. The marginal significance of lagged investment implies that while investment primarily influences output contemporaneously, part of its effect materializes with a delay, possibly due to implementation and adjustment costs.

Joint F-tests further demonstrate that investment and employment variables are collectively significant, underscoring the importance of considering groups of regressors rather than relying solely on individual coefficients. This is especially important in dynamic models, where multicollinearity among current and lagged variables may weaken individual significance while the joint effect remains strong.

Diagnostic tests indicate that the model is well specified, with no evidence of serial correlation, heteroskedasticity, or parameter instability. This supports the validity of standard inference procedures and suggests that the estimated significance levels are reliable. Overall, the findings illustrate that careful testing of statistical significance in dynamic models provides meaningful economic insights and helps distinguish true dynamic relationships from spurious correlations.

CONCLUSIONS AND SUGGESTIONS

This study has examined the problem of testing statistical significance in dynamic econometric models and illustrated its application using regional data from the Namangan region of Uzbekistan. By estimating an ARDL model and applying individual and joint hypothesis tests, the analysis demonstrates how dynamic structures can be rigorously evaluated in applied economic research.

The results confirm that regional economic growth in Namangan is characterized by significant persistence and is strongly influenced by investment and employment dynamics. The statistical significance of these variables highlights the importance of accounting for both contemporaneous and lagged effects when designing and evaluating regional development policies.

From a methodological perspective, the paper emphasizes that significance testing in dynamic models should be accompanied by appropriate pre-testing and diagnostic checking to ensure the validity of inference. Simple reliance on coefficient estimates without considering stationarity, autocorrelation, and stability may lead to misleading conclusions.

Future research may extend this framework to error correction models to capture long-run relationships, to panel dynamic models across multiple regions of Uzbekistan, or to nonlinear specifications that allow for structural changes. Overall, the study confirms that rigorous testing of statistical significance is a cornerstone of credible dynamic economic modeling and an essential tool for evidence-based policymaking.

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